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EDITORIAL

Mechanical Cultivation of Dry-land Soils.

The principal articles in the last issue of this Journal, the Special Mechanization Number of July, reported the results of investigations with mechanical methods of cultivation in padi areas. In the present issue another important aspect of the introduction of mechanization to Malaya is dealt with in two articles by Mr. E. J. H. Berwick, Acting Senior Agricultural Officer (Research), which describe investigations into the mechanical cultivation of dry land soils, in this case coastal clays.

The first article deals with two important problems of cultivation: (a) the fundamental one of soil treatment, and (b) that of the inter-cultivation of crops already on the land. The author points out that such investigations are of necessity of a long-term nature, and his article comprises hypothetical considerations on the cultivation of heavy clays and an interim report on the results recorded to-date. It is, however, already clear that heavy equipment can be effectively used on bare soils only for the drier period of some 2 to 3 months in a year, and that greater efficiency results if a cover of vegetation is left on the soil. A further important conclusion reached is that drainage must be adequately maintained throughout the period of cultivation.

The second article by Mr. Berwick deals with the felling and removal of rubber on coastal clay soils by mechanical methods. This is a subject of considerable importance at the present time in view of the replanting of rubber stands and the possible conversion of some rubber areas to oil palm plantations. Two methods of felling rubber were employed, and the author draws attention to the fact that the presence of root disease in the rubber to be felled affects the choice of implements for felling, since the desirability of complete root removal has to be considered.

Mr. Berwick also makes the important point in relation to the subsequent cultivation of land by mechanical methods, that if mechanization is to be standard practice then the land must be laid out with that object; drains and planting distances must be planned carefully, and headlands must be left on which tractors may turn. Mr. Berwick considers that certain

aspects at least of mechanization applied to agriculture have " clearly come to stay in Malaya." This is a view that will not be seriously disputed, but the acceptance of it implies careful planning of future agricultural development with it well in mind.

Weed Control. Controlling weeds by means of chemicals has been practised with varying success over a period of many years but increased interest in the subject has been aroused in recent years because of the discovery, during the war, that a certain group of chemicals normally concerned in influencing plant growth will cause the plant to die if applied in excess. Furthermore, certain of these chemicals are selective in their effect, killing broad leaved plants at dosages which leave narrow leaved plants unaffected, and are therefore useful for the control of broad leaved weeds in a cereal crop. A large amount of work has been done with these plant growth substances in different parts of the world and on different crops and weeds and there are many papers, both scientific and popular, written on them.

An article in this issue gives a general account of these herbicides together with details of preliminary trials with them in Malaya. It is unfortunate that perhaps the most serious weeds in this country are grasses and sedges which are not readily killed by the " Methoxone " and " 2, 4-D " substances, but the new chemicals do control broad leaved padi weeds, annual weeds, and water hyacinth and will be useful in Malaya on that account. As so much interest has been taken in the possibilities of these herbicides it is hoped that the present article will serve to answer some of the queries about their use and application, but it is stressed that the work described was only of an exploratory nature and by no means exhaustive so that many more uses may suggest themselves to readers in the light of their own particular problems.

Cocoa and the Small-holder. It was recently reported that, at a meeting of a Small-holders' Association, its members were advised that cocoa would be a better long-term investment than rubber in view of competition from synthetic rubber. It is very desirable and necessary to make it quite clear that this statement was not made by an officer of the Department of Agriculture, and that it is not the official view of the Department.

While Professor Cheesman, in his report on the possible development of cocoa cultivation in Malaya, said that " cocoa may well become an important small-holders' crop in Malaya " he also drew attention to the fact that " the successful establishment of " kampong " cocoa will involve either the organization of central fermentaries or the education of numerous small growers in the art of preparation of the beans for sale, and the time will

not be ripe for either for a good many years to come." Professor Cheesman had further comment to make regarding cocoa in relation to kampong agriculture, and his report should be carefully studied by all who seek to help small-holders in their agricultural development.

Editorial comment in this Journal (October, 1948) found Professor Cheesman's above statement encouraging, but pointed out that "No immediate developments in this direction can, however, be expected until the results of experimental work are available, so that it can reasonably be assured that the small-holder will not run any risk of failure in giving up land to this new crop."

This is still the view of the Department of Agriculture and no definite encouragement can be given to the small-holder to plant cocoa in preference to rubber at the present early stage of the experiments in hand.

Extension Work in Agriculture.

Attention is drawn to the abstract of an extremely interesting report on the subject of agricultural extension and advisory work which is published in this issue. The importance of this subject should need no stressing, and the abstract merits close study by all interested in the development of small-holding agriculture.

MECHANICAL CULTIVATION OF COASTAL CLAYS

BY

E. J. H. BERWICK,

Acting Senior Agricultural Officer, (Research).

Introduction.

Much of the extensive area of coastal clays in Malaya has been cultivated for a considerable period with such crops as padi and fruit trees, and at the beginning of the century still more was planted with rubber. Thorough cultivation of these heavy soils with hand labour is difficult, and with the present wage rates, expensive; it was, therefore, considered that cultivation by mechanical means might well have economic possibilities and investigations were started in the latter part of 1948 at the Federal Experiment Station, Port Swettenham, Selangor, on a soil probably as heavy as any in the Peninsula. Investigations of this nature take many years to complete and no figures capable of critical examination are yet available. It has, however, been decided to describe the work already completed as an interim report on account of the interest now being shown in mechanical cultivation, and of the fact that it is now uneconomic to tap much of the rubber on this type of soil because of its low stand owing to disease and wind damage, and that replanting or a change of crop is therefore an immediate necessity.

The problems to be considered are two; the first is the general fundamental method of treating the soil so as to obtain the best possible conditions for planting a crop, while the second is the more particular problem of the inter-cultivation of crops already on the land in an attempt to increase yields and decrease maintenance costs. Work already done on these problems will be recorded, and proposals for work in the future described; where certain types of machinery which it was considered might have been of use were not available, these too will be discussed.

The Nature of the Coastal Clays.

The coastal clays are a comparatively recent alluvial deposit between the inland undulating soils and the coast. On the western side of the Peninsula they form a belt up to 50 miles wide, and they are, in general, heavier than in the narrower belt on the eastern side of the Peninsula (1). They have been studied in considerable detail from a soils point of view (2), and it must be emphasised that they contain some of the most fertile of Malayan soils as is shown by the following typical " total " percentage figures for analyses of plant nutrients.

Soil Type	Lime (CaO)	Potash (K_2O)	Phosphates (P_2O_5)
Heavier soils (Coastal)	0.13	0.80	0.04
Lighter soils (Coastal)	0.02	0.20	0.02
Quartzite (Inland)	up to 0.05	up to 0.10	up to 0.02
Granite (Inland)	up to 0.04	up to 0.05	up to 0.02

The typical soil is a homogeneous blue-grey clay down to a great depth, but in many places shallow layers of peat, never more than a few inches in thickness, may be encountered in the clay at depths ranging from 1 to 3 ft. Beds of sea-shells and sand are frequently found as far as 2 to 3 miles from the present coast line, at depths varying from 4 to 10 ft.

By the very nature of their origin, coastal clays tend to be low-lying and so they have a high water-table and are difficult to drain, but in Malaya their composition makes them rather less 'sticky' than clays in a similar situation in temperate climates. They have, however, a very high water-retaining capacity (3) and water movement through the soil is exceedingly slow, except in those areas which have layers of sand or shells.

An examination of inspection pits in the coconut area of the Federal Experiment Station, Port Swettenham, which has drains 4 ft. wide, 3 ft. deep, and 66 ft. apart, (the common planting practice on these soils using hand-labour), shows that the majority of the feeding roots of the palms are at the sides of the ditches and that, in general, few go to a greater depth than 4 ins. except at the sides of the ditches. During wet weather the clay presents a saturated appearance, but so great is its water-retaining capacity that little water, if any, oozes from its exposed surfaces; such a condition is shown in Plates I and II. Photographs taken in March, 1949, at the end of the short dry season, and shown in Plates III and IV, show a very different state of affairs. The soil has cracked to a depth of over 2 ft., but there is little indication that the coconut roots are taking advantage of their opportunity to tap the new volume of soil thus made available.

General Methods of Cultivation.

(a) The Theoretical Approach.

Investigations to improve soil conditions should, in general, aim at testing operations designed to increase aeration, the percentage of organic matter in the soil and its distribution in depth. In this way it should be possible to facilitate the formation of a 'workable' soil of as great a depth as possible which will retain rain-water and maintain an easy movement of soil moisture; this would mean a practice similar to that used in sugar cane soils in the British West Indies. Briefly the aim would be to construct beds of, say, 20 ft. in width and of as great a depth as practicable, in an attempt to deepen weathering and to provide a working depth of up to 3 ft. In the British West Indies the method normally used is disc-ploughing up and down the bed to a depth of 10 ins. which moves soil towards the centre of the bed

so making a camber from the centre towards the outside; this is evened out or made more steep by means of a grader. The next operation is the construction of a drain between the beds. " Chiselling " follows, in which the rigid tines of a heavy cultivator are drawn through the soil during dry weather as deeply as possible commensurate with adequate fracturing throughout the whole working depth. This should provide optimum conditions for deep aeration, root penetration, and consequent oxidation. The addition of organic matter will then be highly desirable and may be in the form of vegetation grown and and cut *in situ* as a cover crop among tree or shrubby crops, or of a rotation of green manure crops grown in the form of annuals or " cut-and-come-again " perennials. Surface mulching with such cuttings and their partial incorporation in the soil should maintain a porous, absorbant, and stable surface layer of the soil, and together with tillage should allow the maximum absorption of rain-water and minimise the loss through surface run-off. This would also alter the degree of cracking in the dry season, causing more narrower cracks rather than fewer larger ones, but whether cracking is advantageous or not appears to be a matter of dispute on which little information is available. In Indore, with a cotton crop, cracking and the consequent fall of top soil into the cracks causes a "self-ploughing and sub-soiling" (4) which is so intense that mechanical cultivation often becomes ineffective (5), but it is unlikely that this will happen in Malaya where the dry season is less severe. In Trinidad, where conditions approximate more closely to those in Malaya, it is considered on the other hand that excessively close drainage of coconuts on stiff clay causes a wilt which is ascribed to the high water-retaining capacity of the soil, causing, in dry weather, a condition of physiological drought in the crop (6). There are clearly therefore many problems to be investigated; simple trials may give immediate answers to a few of them but others will need properly designed field experiments carried out for a considerable number of years.

(b) Investigation.

A study of the implements needed to investigate the theories described above was made in 1947 (7), but few implements were then available, and it was not until late in 1948 that there were sufficient to use in field experiments. Three experiments were then designed, and all cultivations have been carried out in an attempt to plant in the wet season of October/November, 1949. Details of these experiments are as follows:—

Experiment I. (Expt. Sel. 4/48).

Designed to test certain methods of mechanical cultivation on alluvial clays, in particular deep subsoil cultivation and arching of beds in combination with adequate drainage as compared with normal cultivation.

This experiment consists of 2 blocks in which there are three main treatments:—

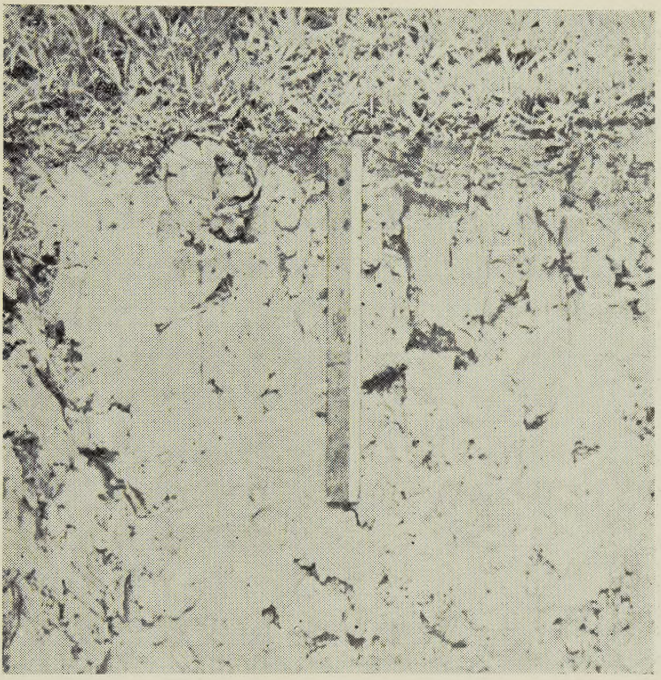

PLATE I.
A typical soil profile, during the wet season, of an area under grass which has received no cultivation.

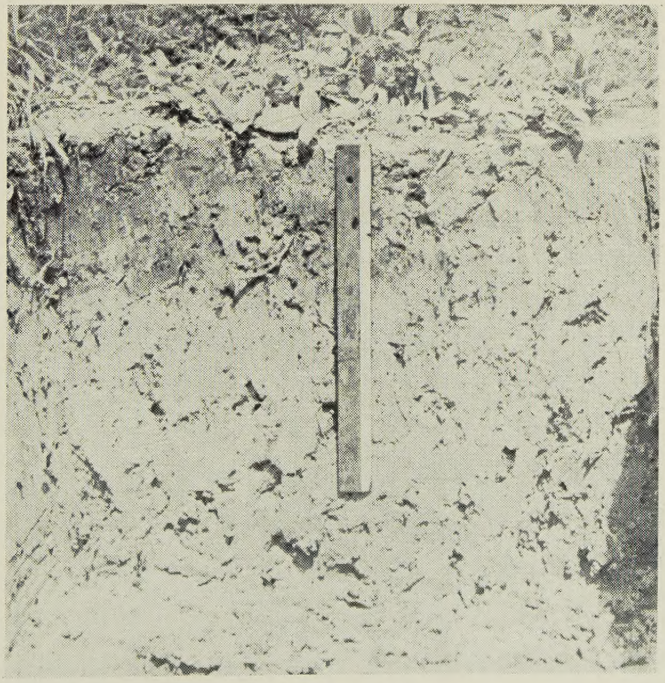

PLATE II.
A typical soil profile, during the wet season, of an area which has been disc-ploughed and cultivated and planted with *Centrosema*.
(The ruler shown is 15 in. long).

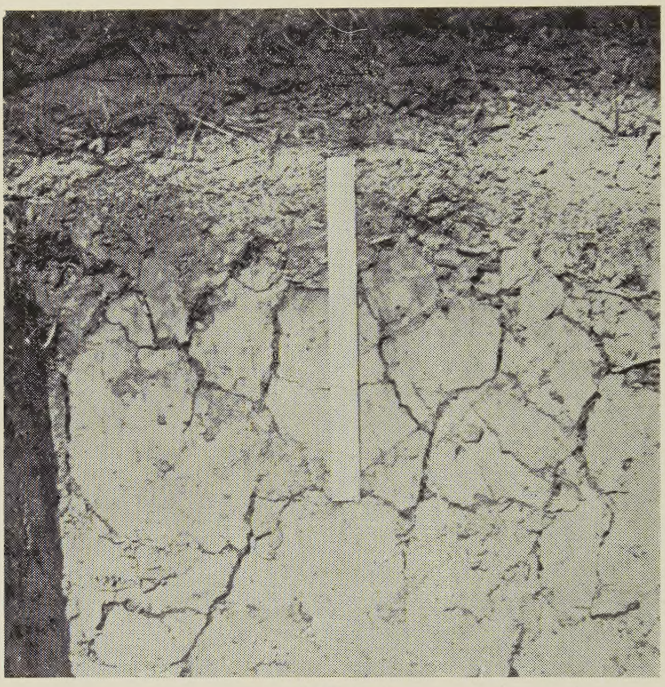

PLATE III.
A typical soil profile, during the dry season, of an area under grass which has received no cultivation.

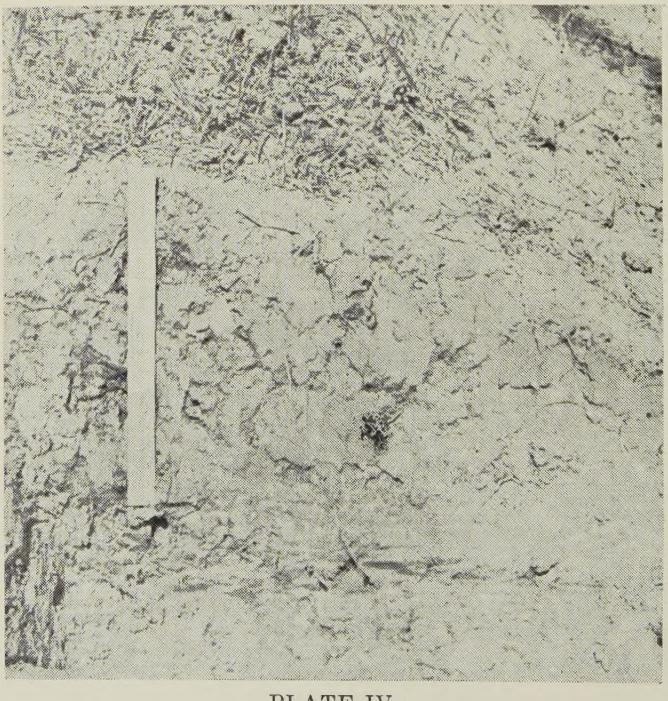

PLATE IV.
A typical soil profile, taken during the dry season at the edge of a ditch. Roots may be seen down to a depth of 18 in.
(The ruler shown is 18 in. long).

(a) Flat beds with widely spaced drains, 60 ft. apart.

(b) Flat beds with closely spaced drains, 20 ft. apart.

(c) Arched beds with closely spaced drains, 20 ft. apart.

Each of these treatments is split into two for chiselling and non-chiselling, that is to say the normal method of cultivation. The main treatment plots are 560 ft. long and 120 ft. wide, and with the necessary discards the experiment extends over 12½ acres. The indicator plant is to be Manila hemp, and incorporated into the experiment are three levels of manuring and four varieties.

Experiment II. (Expt. Sel. 2/49).

Designed to test the drainage requirements of rubber, oil palm, and cocoa on coastal clays.

This experiment consists of 2 blocks in which there are three main treatments:—

(a) Drains 24 ft. apart.

(b) Drains 30 ft. apart.

(c) Drains 60 ft. apart.

Each of these treatments is split into three for the three crops. The main treatment plots are 348 ft. long and 60 ft. wide and the experiment covers some 3 acres. Chiselling will be done on all plots.

Experiment III. (Expt. Sel. 3/49).

Designed to test the effect of chiselling on coastal clays.

This experiment consists of 3 blocks divided for two treatments: (a) chiselled, and (b) non-chiselled. The main treatment plots are 100 x 48 ft., each divided into two areas, one 100 x 16 ft. for one row of rubber, with trees planted 5 ft. apart, and the other 100 x 32 ft. for two rows of cocoa planted 12 x 12 ft. This will in effect mean that there will be hedge planting of rubber 48 x 5 ft. with two rows of cocoa planted 12 x 12 ft. in between the hedges.

(c) Discussion.

Although cultivation work on these experiments is not yet completed, certain points have come to light which may be of interest.

(i) *Lalang Eradiction.*

Certain of the sites selected for these experiments were carrying vegetation which consisted mainly of lalang. This was eradicated without difficulty by disc-ploughs and disc-harrows, thus confirming previous work done by the Department of Agriculture (8).

(ii) *Drainage.*

In certain areas drains had to be filled in order to level the site for the eradication of lalang. In one particular case work started without difficulty in February, 1948, and proceeded until the light rains came in April and May when the land rapidly became water-logged and it was impossible to use heavy machinery. Owing to lack of drainage, conditions rapidly approached

those in a padi field and despite a more severe dry season than usual, it was impossible to use a heavy ditcher on the land with the standard tractor available. This emphasises the point made by Simpson (9) that heavy tractors cannot be used efficiently on coastal clay soil that is inclined to be wet and boggy and that it may be necessary to clear and deepen main drains before starting operations. In the West Indies there is each year a markedly drier season than there is in Malaya, and all cultivations can be carried out with a fair degree of certainty that soil conditions will not be spoiled by rain. In most areas in Malaya on the other hand it is possible that 4 ins. of rain may fall in a day in any month of the year and it is essential that drainage be maintained.

To improve conditions the land was allowed to grow up in natural vegetation, which consisted mainly of reeds and swamp plants, in order to increase evaporation as much as possible, and in November, 1948, although it was impossible to cultivate the land with tractor-drawn implements, it was found that it could be tilled with cable-hauled implements.

The implement used was a John Deere Killefer 35 R panbreaker with an 8 ins. mole-ball which was drawn by a fore-mounted winch on an H.D. 10 tractor, and, although this cannot be recommended as standard practice, working at a depth of 2½ ft., a certain amount of water was removed (Plate V). In this heavy clay, however, it frequently occurred that water would stand in the top of the mole-slit and was removed only from areas close to the mole. Nevertheless the land became dry enough to hold equipment for the digging of drains at the end of the short dry season in April, 1949.

Two types of drainage implements were available for use, the first, the John Deere Killefer 35 R panbreaker mentioned above with a 1912 ditcher attachment which became available at the end of 1948 (Plate VI), and the second, a Cuthbertson ditcher Type F (Plate IX) which arrived early in 1949, and which had not been adequately tested. The Killefer ditcher, according to specifications, requires 80 h.p. to draw it, but it was found that, in this heavy soil, a wide gauge Allis Chalmers H.D. 10 tractor of 85 h.p. pulled it with great difficulty, and in general a Caterpillar D.4 tractor of 35 h.p. was used with it in tandem. The work done by the Killefer ditcher was highly satisfactory and, on its best day, some 4,000 yds. of drain of cross-section 42 ins. at the top, 16 ins. at the bottom and 26 ins. deep were made in 4½ hours. Costs for this operation were 54.8 cents per chain (10).

Drains constructed with the implements described above must be considered as field drains, and tractor-drawn implements are not, in general, suitable for the construction of main drains which are more economically constructed by the use of dragline excavators. The use of these machines was established in Malaya before the war when the Drainage and Irrigation Department operated a large number on the construction of irrigation works; they are now also in use on several estates especially in the Bagan Datoh

PLATE V.
An Allis Chalmers H.D. 10 tractor drawing a mole-drainer across the field.

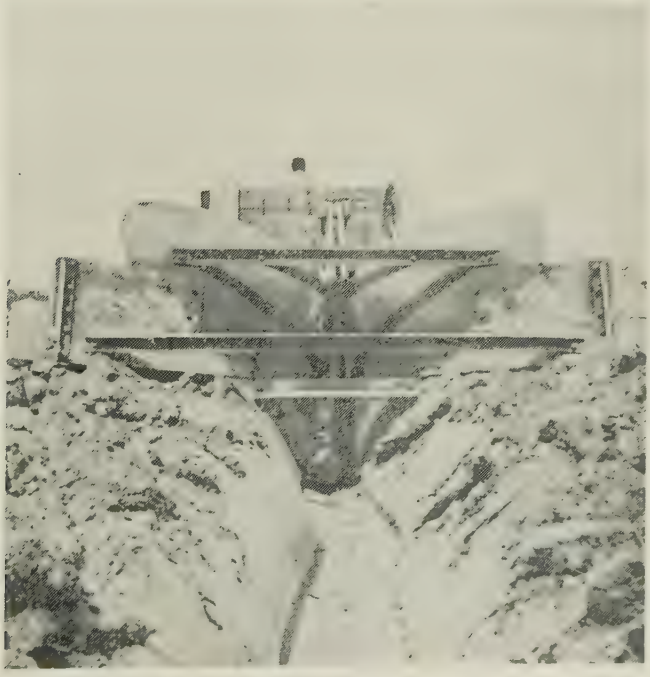

PLATE VI.
A drain being dug by the Killefer ditcher.

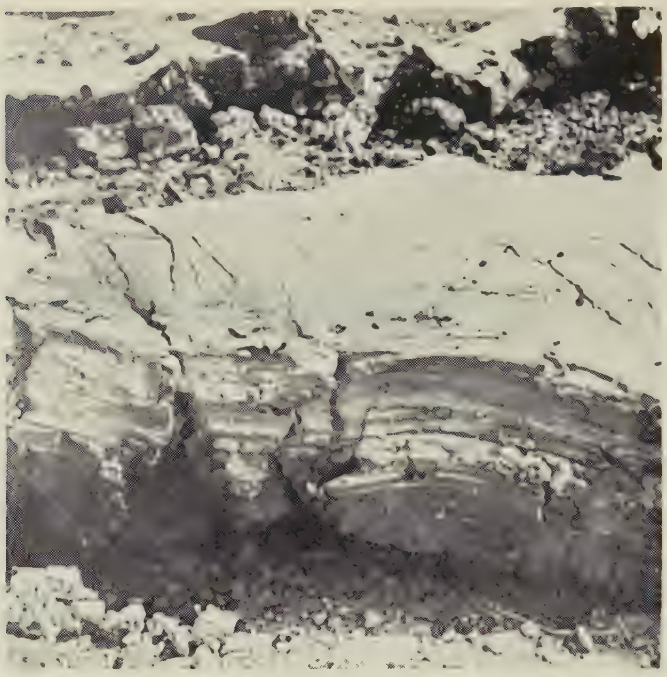

PLATE VII.
The core of earth removed by the Killefer ditcher.

PLATE VIII.
The core a fortnight later showing the effect of cracking.

area of Perak for the construction and de-silting of main drains. In general, costs work out between 41 and 45 cents per cubic yard.

(iii) *Mounding the Beds.*

As mentioned above, in the West Indies beds of some 22 to 30 ft. in width are mounded by means of disc-ploughs working on the level, but when it is necessary to dig ditches first, as appears to be the case in Malaya, the problem becomes more difficult since there is nothing to take the side-thrust of the disc-plough at the side of the bed. Probably the ideal implement for this purpose would be a double harrow-plough so set that the soil is thrown inwards from the sides of the implement to make a ridge. Such an implement does not appear to be made at present, and two sets of heavy disc-harrows were accordingly modified in an attempt to form the ridges in a single operation. Heavy rains and the resulting saturated condition of the soil have stopped trials with this implement.

In one case, however, a satisfactory method of forming the beds was found to be by dozing the " core " of earth formed by the ditcher to the middle of the bed with an angle-dozer on a Caterpillar D.4 tractor. (Plate X). This operation was followed by disc-harrowing with a heavy two-gang disc-harrow which broke down the large clods. (Plate XI). The turning of the implement on the bed was, however, extremely difficult and in practice it is clear that the minimum width of a bed will be determined by the turning radius of the tractor together with its implement. If the planting of crops on beds were to become standard practice in Malaya, the size of the bed would most likely be determined by this turning radius rather than by the theoretically optimum width, at any rate until such time as specialised implements were evolved.

(iv) *Chiselling.*

Chiselling was carried out by means of a John Deere Killefer 7 G2 Chisel Cultivator which had seven tines, spaced 15 ins. apart, giving a working width of 9 ft. (Plate XII). This was drawn by a H.D.10 tractor and, in good conditions, satisfactory fracturing took place down to a depth of 18 ins. When the soil was dry to an insufficient depth, however, it was found that more satisfactory work was done if the depth to which the tines were set was kept above the wet area, as, if the up-thrust caused by the tines was in damp soil, the soil was lifted as a whole and little fracturing took place.

The Inter-Cultivation of Tree Crops.

(a) Investigations.

Inter-cultivation of tree crops is normally carried out for the purpose of removing unwanted undergrowth and to incorporate such undergrowth into the soil. Improvements or alterations to existing drainage systems may also be made in the standing crop and it may be possible to chisel in order to cause fracturing of the subsoil.

Two experiments were designed for coconuts at the Federal Experiment Station, Port Swettenham, on an area which had been drained at 60 ft. intervals. The whole area had been neglected during the Japanese occupation, and in the middle of 1948 when the investigations started, it was under lalang and secondary jungle growth.

Experiment IV. (Expt. Sel. 5/48).

Designed to test whether mechanical cultivation can afford an easy economic means of increasing the yield of standing coconuts and to observe the effect of the implements on the soil.

This experiment consists of 3 blocks in which there are three main treatments:—

(a) Ditched centrally up the plot, ploughed, harrowed and sown with mixed leguminous creeping covers.

(b) Ploughed and sown with mixed leguminous creeping covers.

(c) Control, maintained under existing vegetation and cut with a mower.

Each of these treatments is to be divided into three for the following different methods of cover-control:—

(i) harrowing, (ii) grazing and (iii) cutting with a mower.

The main treatment areas are 750 ft. long by 50 ft. wide and contain two rows of coconuts planted 30 x 30 ft. The sub-treatment plots contain 16 palms which investigation in other countries has shown to be the smallest number with which experimentation can be done satisfactorily. The experiment covers 9 acres.

Experiment V. (Expt. Sel. 6/48).

Designed to test the effect of different kinds of drainage on mature coconuts, the efficiency of methods of controlling creeping covers, and chiselling.

The experiment consists of 3 blocks in which there are three main treatments:—

(a) Ditched, with ditches between each row 30 ft. apart.

(b) Mole-drained, that is to say, alternate open ditches and mole-drains 30 ft. apart.

(c) Control, the normal practice with ditches at 60 ft. intervals.

The whole area is to be sown with mixed creeping leguminous covers which will be kept under control by:

(i) harrowing, (ii) spraying, and (iii) cutting with a mower.

Each sub-plot will then be divided into two for chiselling and control.

Main plots are 700 ft. long and 120 ft. wide, that is to say, they consist of four rows of 25 palms, and with the necessary discards, the experiment extends over 22 acres.

(b) Discussion.

Whether the soil between permanent crops may be cultivated or not, will depend on the type of the crop. With certain orchard crops in

PLATE IX.
A shallow drain constructed by the Cuthbertson ditcher.

PLATE X.
A 'Caterpillar' D.4 Angledozer moving the core of earth to the centre of the beds.

PLATE XI.
Breaking the clods with a 'Rome' cut-away disc-harrow.

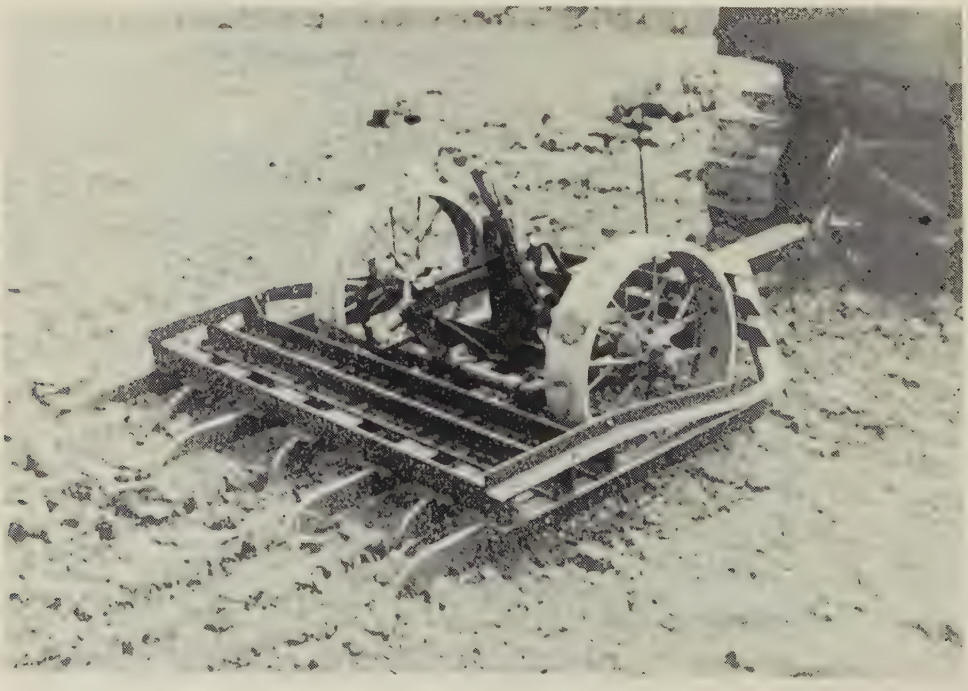

PLATE XII.
The Killefer Chisel Cultivator in action.

temperate climates a common practice is root-pruning annually, and it is possible that disc-harrowing and the consequent severing of many of the surface roots will perform a similar operation, although to a lesser degree. It is considered by many, for example, that the yield of coconuts may be increased by disc-ploughing annually, but no precise evidence is available on this point. In the case of other crops, however, soil cultivation is said to cause a decrease in yield, either (1) because they are themselves intolerant of soil movement as may be the case with cocoa and such fruit trees as durian, (2) because cultivation in certain conditions may cause 'panning' and bad aeration; or (3) because the breakage of their roots renders them exceptionally susceptible to root disease. It is proposed to initiate experiments with the latter class of crops, and the present discussion is confined to coconuts, in which it may be expected that normal cultivation will give increased yields.

(i) *Lalang Eradication.*

The investigations confirmed previous work in which it was found that lalang could be more easily eradicated if it was under shade than if it was in the open. In one particular case disc-ploughing almost completely eradicated lalang in a single operation when it was done in a dry spell followed five days later by a long period of wet weather during which the soil became saturated.

(ii) *Drainage.*

Both open drains and mole-drains were dug without difficulty but it will be impossible to see the effect of this cultivation for some years. The open drains were made with the John Deere Killefer 35 R ditcher and at costs similar to those mentioned above. (Plate XIII).

Mole-draining was done by means of an 8 ins., mole attached to the panbreaker of the same implement. At Port Swettenham this was drawn by the same H.D. 10 tractor as used with the ditcher, but, had a lighter wide-gauge tractor been available, it could well have been used and would have brought the cost down to a figure in the order of 30 cents per chain when drawn at a depth of 3 ft. (Plate XIV).

(iii) *Chiselling.*

Chiselling was done by means of the John Deere Killefer cultivator mentioned above, and although many roots were broken and there was a tendency for the implement to clog up, satisfactory fracturing could be performed to a depth of 12 ins. Considerable damage was done to the root-systems of the palms and there has already been a tendency for the yield to fall. This may be purely temporary and time alone can show whether this type of cultivation can be profitably used with coconuts.

(iv) *Disc-harrowing.*

Disc-harrowing with a D. 4 tractor and a heavy Dyrr offset disc-harrow could be performed at a cost of about $8 per acre. It was, however, difficult

to cultivate close to the bases of the palms, and for the purpose of obtaining a seed-bed for sowing mixed creeping covers, a Farmall A tractor drawing a single gang of light disc-harrows was used which cultivated to slightly less depth but was at the same time less expensive.

The effect of heavy disc-harrowing is not unlike that obtained by disc-ploughing, and the soil profile shown in Plate II gives an idea of the improvement in a soil which may be brought about by disc-ploughing to a depth of 6 ins., disc-harrowing, and planting with *Centrosema*. In Plate I it will be seen that the top soil extends at the most to 3 ins. below the surface of the soil whereas when it has been disc-ploughed it extends to 6 ins., in depth.

(v) *Cover Control.*

Covers are not yet well enough established for control to be necessary, and, therefore, no information is available.

Conclusions.

As the investigations which have been described are of a long-term nature, few conclusions can be drawn. Several points have, however, been made abundantly clear; the first is, that on heavy clays of the type described, the possibility of mechanical cultivation depends largely on the weather. If heavy equipment is to be used, by which is meant implements which require crawler tractors of 80 h.p. or over, greater efficiency will be obtained if the soil is left with a cover of vegetation than if it is disc-harrowed to leave a bare surface on which track-skid will be frequent. In 1949, conditions were such that heavy equipment could be used for 4 to 5 weeks only. It may be considered that this was an exceptional year, but it is unlikely that heavy equipment can be used efficiently on such types of soil for more than 2 to 3 months even in the best season. Lighter tractors, such as wheeled or crawler tractors of 25 to 40 h.p., may probably be used for 8 or 9 months each year for inter-cultivation work where the soil is left covered by vegetation. Whenever it is possible to use tractors they should, therefore, be used as long as practicable and night work will probably be essential.

Finally it must be emphasised that on coastal clays drainage must be maintained throughout the period of cultivation, even if it means the digging of temporary drains. In Malaya, to fill drains in an attempt to eradicate lalang in the expectation of dry weather, for example, is to ask for trouble. The first operation should invariably be a clearing of old drains or the construction of new ones.

Summary

Coastal clays cover an extensive area on each side of the Malay Peninsula. They are low-lying and "heavy" but, for Malayan soils, they contain a high percentage of plant nutrients. It was considered that cultivation by mechanical means might have economic possibilities, and investigations started at Port Swettenham, Selangor, in 1948,

PLATE XIII.
A drain constructed by the Killefer ditcher between lines of coconuts.

PLATE XIV.

are described. As they must be of a long term nature, few conclusions can be drawn but it is pointed out that in Malaya heavy equipment can be used on bare soil for not more than 2 to 3 months even in the best seasons and that it is essential that drainage be maintained throughout the period of cultivation.

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THE REMOVAL OF STANDING RUBBER ON COASTAL CLAYS

BY

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Introduction.

The general problems concerned with fundamental methods of treating coastal clays in Malaya, together with relevant investigations, have been discussed in a previous article (1). The investigations described showed the desirability of conducting a comprehensive field experiment on drainage requirements on these soils and, as there was no suitable land on the Federal Experiment Station, Port Swettenham, arrangements were made for it on a nearby estate, which had a large area of rubber on a similar soil, which it was intended to convert to oil palm. This offered an opportunity to test various types of clearing implements, and experience with them is described in the present article.

The remarks made in the previous article under "Conclusions" apply equally to the removal of standing rubber, and it is only necessary to emphasise here that drainage must be maintained throughout all operations and that, when dry weather occurs and the soil is in a condition in which heavy tractors may be used efficiently, work must proceed as rapidly as possible.

The operations already carried out are felling, heaping and burning, and rooting, but a satisfactory burn has not yet been effected. Other operations which will consist of ditching, forming of beds and chiselling have not yet been completed.

Investigations.

FELLING.

Felling was carried out by two methods, firstly by means of a stumper on a Caterpillar D. 8 tractor and secondly by means of a wire cable drawn between two heavy crawler-tractors. The operation with the stumper is shown in Plate I. In the case of the smaller trees it was possible for the tractor to approach, place the stumper against the trunk some 4 ft. above ground level and push it down directly; it then reversed and by placing the stumper below the bole of the tree, the tree was removed completely from the crater. In the case of large trees it was often necessary to use the stumper blade to cut the lateral roots before the tree could be felled. This in many cases necessitated the removal of earth between the tractor and the tree and, when the tractor approached the tree, the fore-end went into the hole and the stumper hit the tree close to the ground, thus losing leverage.

PLATE I.
A Caterpillar D. 8 tractor with stumper attachment felling a rubber tree.

PLATE II.
The trees stacked in windrows of three rows.

PLATE III.
A rubber tree being felled with a rope.

PLATE IV.
The rope tangled up amongst the large branches.

Working under various conditions emphasised the fact that the amount of power that could be brought into effective operation on the tree depended, not so much on the horse-power of the tractor, as on the amount of purchase the tractor could obtain on the land. In fact the limiting factor was not the horse-power of the tractor but track-skid.

In general it was found that by this method it was possible to fell and stack in lines of three rows (Plate II) at the rate of 15 to 20 trees per hour which would cost 50 to 67 cents per tree or $35 to $45 per acre.

In the second method a wire cable of ¾ in. diameter attached to the drawbar of two heavy crawler-tractors, those available in this case being a Caterpillar D. 8 and a Caterpillar D. 7, was placed as high as possible up the trunk of the tree (Plate III); the two tractors then moved down the rows. In theory the whole row of trees is pulled out so that the crown of one tree is lying on the uprooted bole of the next. Tests were made with uprooting one row at a time and also two rows at a time, as it was hoped that in the latter case it might be possible to obtain a good burn with the trees as they lay. In practice several difficulties were encountered caused mainly by the wire cable not rolling smoothly over the trunk of the tree but cutting into it or becoming entangled with the main branches (Plate IV). Gaps in the stand, which occur frequently in old rubber, also caused considerable delay since the wire cable had to be lifted into position again in order to get sufficient leverage to uproot the trees. Swivels were attached to the cable in order to assist it to roll but they were not entirely satisfactory. In bad conditions work was slow and as many as 10 labourers had to be employed to lift and disentangle the cable. In good conditions when the land was dry and the tractors could exert their full power trees could be uprooted at considerable speed, often at the rate of over 100 per hour which would bring the cost down to 25 cents per tree or $17 to $20 per acre. In many cases large branches of the trees were broken off which when dry would form useful kindling for the burn but in other cases the roots of the tree were not all pulled out of the ground with the result that the tree did not die which seriously impeded the burn.

In coastal clays, which generally have a high water-table, rubber does not send down a deep tap root but confines itself largely to laterals. In Plate V the small tap root can clearly be seen. The craters formed when the trees are felled are a constant source of trouble as not only does the tractor become bogged in them but they form a breeding ground for the larvae of malarial mosquitoes which is difficult to control, especially when the crater is covered by a mass of branches.

Heaping and Burning.

A good burn is essential for later mechanical cultivations, and the amount of heaping which is required will be controlled by the number of rows which must be heaped together to obtain a satisfactory burn in the weather conditions obtaining at the time. The burning of recently felled jungle is

easier as it contains a large amount of undergrowth and saplings which act as tinder for the fire, but in the case of rubber this material is normally not present. Attempts were made to burn rubber stacked in lines of one row, two rows and three rows respectively, but in the unusually wet conditions in July and August, 1949, a satisfactory burn was not obtained and it is considered that the minimum number of rows which must be stacked together in average weather conditions is probably in the order of six. Stacking was done by means of the Caterpillar D. 8 tractor with a stumper attachment or root-rake attachment, a Caterpillar D.7 with a bulldozer blade and a Caterpillar D. 4 with a root-rake, and of these the root-rakes proved to be the most successful. If the operation were to be done on a large scale it would be found that a team of crawler tractors would be necessary which would probably consist of two of the 100 h.p. class and four of the 45 h.p. class. If this were done, costs would probably work out at $25 to $30 per acre.

Rooting.

Rooting for a stumped area has been described in a previous article (2). The only difference found in this case was that the roots tended to clog up the implement more often (Plate VI) and costs might therefore be increased by a half to bring the figure to $15 per acre.

Discussion.

The presence of root disease in the standing rubber and the susceptibility of the crop to be planted in its place will influence the choice of implements to be used in felling. If the incidence of root disease in any area is high, to replant rubber without removing as many of the rubber roots as possible will almost invariably necessitate the spending of a large amount of money on disease control later on; on the other hand if an alternative crop which is resistant to the prevalent fungus can be substituted then the removal of the rubber roots would no longer be necessary. Table I shows the susceptibility of the main crops in Malaya to the most common root diseases as far as at present is known. In this connexion it should be noted that it is necessary to remove only the bulk of the root system and that, if the root system is sufficiently broken, it is unlikely that the fungus will spread far and it should be possible to control it cheaply.

The common method of destroying rubber trees at the present time is by poisoning with sodium arsenite which is both cheap and effective, working out at the rate of 9 to 15 cents per tree (3). The main objections to it are: firstly that it cannot be relied upon to eliminate existing sources of root disease; secondly that when root disease does appear in a replanting made in a poisoned area the cost of its control is much increased by the presence of the rubber stumps which form a bulky source of infection; and thirdly that it prevents, at any rate for some years, the use of tractors for inter-row cultivation as the area becomes covered with fallen timber.

PLATE V.
The earth attached to an uprooted tree, showing the small tap-root.

PLATE VI.
The rooter clogged up with roots and small branches.

Table I.

The Susceptibility of Various Crops to Root Diseases.

Fungus	Rubber	Coconut	Oil Palm	Tea	Cacao	Manila Hemp
Fomes noxius	Susceptible. Common in Malaya.	Reported to be susceptible but not recorded in Malaya.	Causes stem rot but not root disease. Recorded in Malaya.	Susceptible. Fairly common in Malaya.	Susceptible. Not recorded in Malaya.	Not attacked.
Fomes lignosus	Susceptible. Common in Malaya.	Reported to be susceptible but not recorded in Malaya.	Saprophytic on leaf bases: does not cause root disease.	Susceptible. Does not appear to be common in Malaya.	Susceptible.	Not attacked.
Ustulina zonata	Susceptible. Common in Malaya.	Not susceptible.	Recorded as causing root disease and rotting of leaf bases in Malaya.	Susceptible. Common in Malaya.	Slightly susceptible. Not recorded in Malaya.	Not attacked.
Ganoderma pseudoferreum	Susceptible. Common in Malaya.	Not attacked.	Not attacked.	Susceptible. Common in Malaya.	Susceptible. Common in Malaya.	Not attacked.
Spaerostilbe repens	Susceptible. Fairly common in Malaya.	Not attacked.	Not attacked.	Susceptible. Occurs in Malaya.	Susceptible. Not recorded in Malaya.	Not attacked.

If the roots can be left in the soil, then it may be possible to use a large circular saw of the type worked from a tractor. If it is possible to cut the bole of the tree at ground level by this means, then inter-row cultivation could be done by means of stump-jump ploughs and harrows such as are now being manufactured in Australia.

If it is essential that the roots be removed, it is best that the trees be felled by means of a tree-dozer, an attachment which makes contact with the tree at a much greater height from the ground than does the stumper. If such a dozer were mounted on a crawler tractor of the 100 h.p. class, the experience gained with the stumper previously mentioned gives reason to believe that the extra leverage obtained with a tree-dozer would make the felling of the largest trees comparatively easier, and much less disturbance to the soil by track-skid would be caused.

It must be emphasised that if an area is to be cultivated mechanically it must be laid out for it, drains and planting distances being so arranged that the implements can cover the whole of the area, and headlands being left so that the tractors may have room to turn. Mechanization is now an accepted aid to agriculture in all parts of the world and it has clearly come to stay in Malaya. If new areas are to be planted or old ones replanted then in the interests of the future, steps should be taken before the planting of the crop to ensure that the maintenance of soil fertility and upkeep be carried out in the most economic way which, if the standard of living of the labourers is to improve, is almost certain to be mechanically.

Summary.

The felling of old standing rubber on coastal clays by two methods is described, the first by means of a stumper on a Caterpillar D. 8 tractor, and the second by means of a wire cable between two heavy tractors. Heaping and burning, and rooting are also described. In the discussion which follows it is pointed out that presence of root disease in standing rubber and the susceptibility of the crop to be planted in its place will influence the choice of implements to be used in felling, and in a table the susceptibility of the main crops in Malaya to the common root diseases is shown. The common method of destroying rubber trees in Malaya at present is by poisoning with sodium arsenite. This is both cheap and effective but certain objections to it are enumerated.

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THE USE OF PLANT GROWTH-REGULATING SUBSTANCES AS WEED KILLERS

BY

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Introduction.

The problem of controlling weeds is a very old one and the amount of money, time and labour spent in doing so is well known. The use of chemical herbicides is an established practice and many different compounds are used for this purpose. The mode of action of these varies and they may either plasmolyse the plant cells, oxidise the substance of the plant body, or otherwise poison the living tissues. They may be general in effect, killing all plants, or they may be selective, in killing some but not others; and they may be contact type, killing only where the spray falls, or they may be translocated through the plant to kill it down to the roots. Such poisonous and corrosive types of herbicides include arsenites, arsenates, chlorides, chlorates, sulphates, sulphuric acid and many others. They have certain obvious disadvantages.

Recently, however, a new means of killing weeds has been discovered with the use of chemical substances which cause the plant to undergo a period of abnormal physiological activity such that the entire metabolism breaks down and the plant dies. This effect is brought about by plant growth-regulating substances used in greater strengths than for their normal function, and which, synthetically produced, now form the bases of herbicides of this new type.

Plant Growth-control Substances as Herbicides.

In 1935 it was discovered that growth-control substances, previously only obtainable by extraction from plant tissues, could be manufactured chemically. These synthetic growth-control substances (plant "hormones" in U.S. literature) attracted a lot of attention from research workers and practical horticulturalists, the latter using them chiefly for setting fruit and for developing root systems on cuttings. The idea of using them as weed killers seems to have arisen independently both in England and in the U.S.A., during the war years, but as no results were published until 1945, for security reasons, the investigations proceeded along separate lines.

It was discovered that phenoxyacetic acid and its derivatives were especially active in certain respects, and these were selected for weed control work. When they came to be used it was apparent that although these substances at some strengths were potent killers of broad-leaved plants they appeared to have little or no effect on many grasses and other narrow-leaved plants and so it became possible to put them to use as selective herbicides, particularly for control of broad-leaved weeds in cereal crops. Initial success in England, for example, was with M.C.P.A. (*v. infra*) in control of charlock (*Brassica sinapis*) in wheat. After the results of this research work were made known growth-control substances rapidly became popular, and to-day are widely used for weed control in many different crops.

Chemical Composition of Herbicides.

In England the compounds chiefly used in the preliminary stages of the work were 2, 4-dichlorophenoxyacetic acid (D.C.P.A. or 2, 4-D.) and 2 methyl-4 chloro-phenoxyacetic acid (M.C.P.A.—" Methoxone "). M.C.P.A. was first selected for large scale manufacture but now the sodium salt and ethyl ester of 2, 4-D are also marketed. In U.S.A. 2, 4-D and 2, 4, 5-tri-chlorophenoxyacetic acid were used at first and now 2, 4-D compounds—salts, esters and ethanolamine salts—are mainly manufactured. 2, 4-D is rarely used in its acid form as it is almost insoluble in water and has other disadvantages of preparation. The salts and ethanolamine salts of 2, 4-D are readily soluble in water, the esters are oil soluble.

The salts manufactured for general use are those of sodium and ammonia and are sold as powders to be dissolved in water or to be applied as dusts. Where the salts are marketed to be applied as dusts they already contain a large percentage of inert matter, but when the commercially pure salt is to be used as a dust inert matter must be added for easy coverage of the area to be treated.

The esters available are methyl-, ethyl-, butyl-, isopropyl and amyl- and are sold in oil solution with an emulsifier added so that the solution readily mixes with water to form a milky emulsion.

Of the ethanolamine salts di- and tri- are marketed as powders which can be dissolved in water, or used in an oil emulsion, as required.

M.C.P.A. is available as a water solution which can be diluted as required or in a 1 per cent. dust with inert matter for easy application. The 2, 4-D acid is available and is sold in powder form, but is difficult to dissolve in water. It can be used with the help of a wetting agent.

Application of Herbicides.

Plant growth substances can be applied to established plants or to the soil. When applied to plants they can be used as a spray or dust. The amount of active chemical required is quite low, usually about 1¼ to 2½ lbs. per acre, depending on the type of weeds present, stage of growth, the crop, climate etc., but the quantity of any particular commercial

herbicide used may vary greatly according to the strength of the preparation. Great care must be exercised in calculating this since solutions and dusts are sold with contents from 100 to 1 per cent. active principle, and under-doses will not affect the weeds, while over-doses may adversely affect the crop.

The dilution of the standard amount of herbicide recommended for application varies from as little as 5 gallons to as much as 200 gallons of water per acre. The lowest rates of dilution, however, usually apply to ester emulsions and not to water solutions.

The rate of dilution may depend to a large extent on the spraying equipment available. In general, in consideration of transportation costs and labour of application, the less water used the better, but the limiting factor, particularly in the tropics, must be the rate of evaporation, as a finely atomised water solution is liable to evaporate too rapidly from leaf surfaces to allow for penetration of the cuticle. Too low a rate of dilution, therefore, may not always be practical, even if suitable spraying equipment is available. Furthermore, whatever the quantity of water used it is essential to get even coverage with the herbicide, and without much experience and careful calculation this may be easier to achieve with least error with relatively greater dilutions rather than lesser.

When a dust is applied in place of a spray 99 parts inert dust to 1 part of 100 per cent. herbicide is a convenient formula but the mixing process must be done very thoroughly, preferable by machine for good results. It should be noted that dusting is generally considered the least efficient method of treating established dry-land weeds and the higher dosages of 2½ lbs. of pure chemical per acre should be applied. For soil applications the dosage is the same as for dusting plants, and the powder is spread on the soil surface and mixed in to the top 2 to 3 ins.

Effect on Plants.

These growth-control substances, although as generally used they are most effective on broad-leaved plants, will to some extent affect all plants either in some particular growth stage, or if the dosage is high enough. For this reason great care often has to be taken in their application as selective herbicides.

They stimulate cell-division and growth first of all at point of contact and morphological effects are early seen in twisted leaves and stems, while physiological changes also occur with a great increase in respiration and consequent rapid depletion of carbohydrates stores. They thus cause death of plants by too great stimulation of the metabolic rate.

The first signs of injury are found in herbaceous stems and leaves, which twist and curl. Growth points and flowers and new leaves in bud stages are also affected. There follows a break down in the chlorophyll of the leaves, causing either yellowing, mottling or abnormal darkening.

These symptoms may take up to two weeks to show clearly although they may be evident a few hours after spraying or dusting. The underground parts of the plant are also affected, all growth being inhibited until finally the roots split and disintegrate. A partial recovery may take place and many plants take up to four weeks to die. Full recovery may be achieved in woody plants or plants with extensive underground reserves and respraying at intervals will be necessary for complete kill.

Closely related plants, however, react differently to M.C.P.A. and 2, 4-D substances, and it is not always possible to predict how a particular species will be affected.

Comparison of Performance.

M.C.P.A. and the 2, 4-D acid, its salts, ethanolamine salts and esters are all effective weed-killers but M.C.P.A. does not always act in the same way as the 2, 4-D compounds, some plants being more susceptible to one, some to the other. 2, 4-D ester preparations seem slightly superior in herbicidal action and this may be partly due to the physical characters of emulsions which give better contact between the droplets and the leaf surface than do water droplets. This better contact of leaf to solution enables more rapid penetration and absorption so that esters can be effective even if rain falls within a short time of treatment or if the evaporation from the leaf is rapid, conditions which adversely affect the primary and amine salts used as water solutions. A recent theory, however, put forward to explain how these herbicides penetrate plant tissues suggests that the reason is more fundamental and that absorption is controlled by the composition of the chemical. An oil soluble compound will penetrate leaf tissue easily but root tissue with difficulty, while a water soluble compound will penetrate root tissue easily but leaf tissue with difficulty due to the molecular structure of water and oil soluble compounds. This being so, salts, ethanolamine salts and M.C.P.A. can best be used for soil treatments and for weed seed control, while the esters should be used for spraying foliage, although under reasonable conditions both groups can be used effectively. When adverse conditions are anticipated and rapid absorption is required, this theory presents a useful guide which can be applied in the case of any herbicidal compounds, not only those already mentioned.

Factors Affecting Effectiveness of Sprays.

As all work on the subject is comparatively recent it is not possible to predict precisely the optimum conditions for effectiveness of sprays but certain factors are known to have some effect on their performance. These are temperature, light intensity, rainfall, and age of plant.

Temperature.—It has been found that in general the higher the temperature at time of treatment the better the kill. The controlling factor, however, is the growth rate of the plant, the more favourable results being obtained when the plant is growing rapidly, which is to some extent dependent on temperature. Optimum temperature for rapid growth varies according to

the individual plant concerned, so optimum spraying time as regards temperature also varies.

Light Intensity.—2, 4-D and its allies are more effective in sunlight than in shady places. The theory put forward to explain this is that the herbicide is translocated with the carbohydrate manufactured in the leaves, and some supporting evidence may be obtained from the fact that in the U.S.A. it has been found that plants sprayed in late spring and early summer are more susceptible than when treated later in the year. The former period is the time when plants are manufacturing carbohydrates most rapidly, while in autumn less are manufactured and translocated.

Rain.—As previously explained, rain, in washing off the aqueous solutions, will prevent adequate absorption of herbicide by the leaves; this does not apply so much to oil sprayers or emulsions. Water acts with temperature in controlling the rate of plant growth and therefore rain, as soil moisture, will also aid the action of killing the plants.

Soil Conditions.—In the case of soil treatments the effectiveness of the treatment depends on soil moisture, temperature, and to some extent composition of the soil. An alkaline soil for example will retain the compounds longer, while a warm moist soil will inactivate the herbicides rapidly.

Age of Plant.—In general young plants are killed more rapidly than older ones. This is probably related to the fact that young plants are more active physiologically than older ones and more translocation occurs within the plant.

Advantages Over Other Weed-Killers.

Plant growth substances are superior to many other weed killers in that they are selective in their action, and very small quantities of the active chemical are required for treatments. They are not poisonous to insects, to fish in waterways, livestock, or humans, and there are no fire risks or injury risks in handling them.

The fact that they can be applied in a small quantity of water, if the necessary power spraying equipment is available, allows considerable reduction in the cost of water haulage to fields.

Spraying or dusting of plants has no effect on the soil; even when soil treatments are done the effects of a normal application pass off in one or two months so the land is not out of action for any long period.

Disadvantages of Plant Growth Substances.

The chief disadvantage of these herbicides lies in their potency. Although 2, 4-D compounds do not seriously affect many mature narrow-leaved plants, they do have an effect on young stages and especially on young organs of any plant; for example, if a cereal crop is sprayed at the time the flowers are emerging, distortion of floral organs and loss of grain will occur.

Another great danger is that the spray or dust may drift and cause damage to nearby plants. A serious example of this occurred in Louisiana and Texas, U.S.A., where, when rice fields were being dusted from the air, cotton plants for several miles around suffered severe defoliation and foliage distortion as also did vegetables and ornamental plants. It is of interest, however, that the cotton plants recovered and gave a better yield than usual for the season. Whatever may have been the reason for this, it indicates, at any rate, that no permanent damage was caused by the 2, 4-D dust, to the woody cotton plants.

Allied Herbicidal Phenols.

Pentachlorophenol has been used with moderate success as a component of oil emulsion sprays for weed-killing in market-garden crops. This emulsion has also been used for destroying grass weeds in general. Pentachlorophenol is, however, difficult to dissolve in oil, and has given very varying results, possibly for this reason.

The most important recent (1947) herbicides discovery in the U.S.A. has been Dinitro-sec-butylphenol, which dissolves readily in oils and is much more effective as a weed-killer emulsion than pentachlorophenol. It is hoped to be able to try this in Malaya, and supplies have been ordered but have not yet arrived.

Use of Plant Growth-Control Herbicides.

The growth-control substances may be used in a fairly wide range of circumstances either as selective herbicides or otherwise. As selective herbicides they have been used successfully against broad-leaved weeds in cereals of all kinds, in flax, in lawns and pastures, in many plantation crops and in some nursery and market garden crops.

In eradicating weeds non-selectively they have been very successful against water hyacinth. They have occasionally been used to control woody weeds such as Lantana, vines, honey-suckle, and blackberry-brambles, also raspberries and similar bushes, single treatments killing back the foliage only, and not affecting the root systems. They have been partially successful in killing certain reeds and sedges.

It should be borne in mind, when considering treatment of tropical lawns, that *Axonopus* spp. (Carpet grass) and *Digitaria* spp. (Serangoon grass) are susceptible and readily killed by some of these herbicides, making their use inadvisable. Tomatoes, potatoes, all legumes, all brassicas, many garden herbs, and most ornamental broad-leaved plants are killed or damaged by 2, 4-D compounds and similar herbicides, making them unsuitable for extensive use in mixed flower or vegetable gardens.

Use of Plant Growth-Control Substances as Herbicides in Malaya.

These growth-control herbicides as weed-killers are becoming more frequent subjects of public enquiry in Malaya, and both a general survey and an outline of preliminary local experimentation in applications of these herbicides may be appropriate.

In Malaya there are many weed problems comparable to those in temperate countries for which 2, 4-D compounds suggest themselves. As the climate and often the cultivation methods differ widely, however, from those where the herbicides were originally tested, caution has to be exercised, and the methods which have been evolved elsewhere usually cannot be adopted without modification.

The chief problems here are weed control in rice fields, control of water hyacinth and coarse grasses in water courses, and control of lalang (*Imperata cylindrica*) in plantations.

Water hyacinth readily succumbs to treatment, but unfortunately the worst of rice-field weeds are grasses, and these, with the grasses of water courses, and lalang are not affected by 2, 4-D.

Major problems of weed control in Malaya, therefore, are not solved by the use of these plant growth-control substances as selective or general herbicides.

Preliminary trials were carried out during the middle of 1948 to get some information on spraying equipment, coverage and evaporation rates under local conditions, and the results were used to plan later trials some of which are still in progress. In general the effect of high temperature and humidity gave over-rapid evaporation of the spray when established weeds were being treated. It was found that a fairly coarse spray and at least double strength herbicide was required and, even so, old established weeds did not readily succumb to treatment. These trials were carried out in the absence of a crop.

In other trials on water weeds and rice-field weeds the lower recommended dosages were effective and gave good control of weeds. Trials which have been or are being carried out to-date by the Department of Agriculture have been done in collaboration with Officers of the Drainage and Irrigation Department.

Trials have been carried out using samples of herbicides available locally. Products received and used to date are:—

Composition.	Commercial Name.
M.C.P.A. (Methoxone).	" Agroxone "
D.C.P.A. (2, 4-D acid).	—
Sodium salt 2, 4-D.	" Fernoxone "
Ethyl ester 2, 4-D.	" Weedone "
Butyl ester 2, 4-D.	" Weed-no-more "
Tri-ethanolamine salt 2, 4-D.	" Barweed "

Rice Field Weeds.

Work on spraying rice fields to control weeds has been carried out on a large scale in Louisiana and Texas, U.S.A., but as cultivation practices differ in this country it was not possible to apply these results directly, particularly in regard to application time. Here, with usually at least one

nursery period, it has been found that a suitable time for application is one month after the rice plants have been transferred to the sawahs. This is about the time of first weeding, and treatment at this point controls the weeds without damaging the crops.

In a trial carried out at Kendong Padi Test Station, Negri Sembilan, it was observed that, when chemical was applied, there was at first a slight browning of the padi leaves but recovery was rapid. All broad-leaved plants* were killed and even the sedges were sufficiently effected to ensure some control during the rest of the season. One spraying gave as good weed control as two hand weedings which is the usual practice at this Station. Crop yield in treated and hand-weeded control plots showed no significant difference. The compounds used at Kendong were sodium 2, 4-D and tri-ethanolamine 2, 4-D applied at the rate of 1¼ lbs. per acre in water solution, using a knapsack sprayer.

Kendong was an example of the most suitable use of 2, 4-D because the weeds in the main were broad-leaved ones. It must be stressed, however, that many of the most persistent padi field weeds are grasses on which 2, 4-D will not be effective, and efficient control of rice field weeds cannot be achieved by means of these selective herbicides.

A similar trial was carried out at Sungei Manik, Perak, and results have served to confirm the fact that chemical control of rice field weeds is not yet possible.

Weeds in Water Courses.

The problem of clearing water courses is primarily the responsibility of the Drainage and Irrigation Department which has carried out several trials, often in co-operation with the Department of Agriculture. One of these at Sangland, Perlis, was conducted by the Senior Drainage and Irrigation Engineer, Kedah and Perlis. Here a 1/60 and a 1/100 emulsion of the ethyl ester of 2, 4-D were used against water-hyacinth in still water; the emulsions were applied at the rate of 160 gallons to the acre. Both emulsions gave good control of water hyacinth, the heavier dosage 1/60 giving complete kill in three weeks, the 1/100 solution taking a month for complete kill, but spot spraying was required to kill off individual plants.

A similar trial was carried out at Bachang, Malacca, in a water course, using sodium salt of 2, 4-D and the ethyl ester of 2, 4-D. In this trial the sodium salt gave good control but the other treatment allowed the plants to remain floating and some regrowth took place. This, however, was controlled by a second spraying. Other trials were carried out in Province Wellesley, and are in progress in Kedah and Kelantan.

Trials have been carried out on the control of the coarse water grass, *Hymenachne myuros*, at Pulau Gadong, Malacca, but an ester emulsion had

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* *Jussiaea suffruticosa* Linn. *Phyllanthus urinaria* Linn.
Commelina mudiflora Linn. *Eichhornia crassipes* Solms.
Vandellia pedunculata Benth. *Monochoria hastaefolia* Presl.
Limnocharis flava Bucharan.

no effect, and confirmatory trials elsewhere have corroborated this; again, stress must be laid on the fact that where drains are choked by grass, 2, 4-D alone is not successful. As there is no need for selective action in ditches an oil emulsion fortified with 2, 4-D compound or allied chemicals, such as pentachlorophenol or dinitro-sec-butylphenol, might find a useful application here. Oil may, however, prove an unwelcome contamination for water courses.

Arable Land.

Various trials were carried out on established weeds in the Nursery, Federal Experiment Station, Serdang. In general the results obtained were very poor, indicating that a very heavy dosage of herbicides is necessary. *Mimosa* spp. were only slightly affected, *Mimosa invisa* slightly more so than *Mimosa pudica*. *Digitaria* spp. were killed, *Eleusine indica* hardly affected at all, and *Axonopus compressus* was seriously affected by 2, 4-D.

Nut-grass, *Cyperus rotundus*, was superficially affected but not controlled even at higher rates of application, but a further trial is in progress with a wide selection of herbicides used at varying strengths. No results are yet available but indications are that 20 lbs. herbicide per acre may have some effect.

Mimosa pudica in Pasture.

Another trial was carried out at Serdang on the control of *Mimosa pudica* growing in savannah grass, *Axonopus compressus*. The chemicals used were "Methoxone" and sodium 2, 4-D. Sodium 2, 4-D readily kills *Axonopus compressus* and leaves the Mimosa unaffected but ethoxone appears to control the Mimosa without harming the savannah grass except at high dosages. The most effective treatment in control of Mimosa, without damage to the Axonopus, was at the equivalent of 4 lbs. of 100 per cent. Methoxone per acre. A further trial is being carried out.

In general the equivalent of 3½ lbs. of Methoxone per acre may be recommended as the best treatment. Two or three applications might be required. In practice, however, such treatment would not always be spread over the whole pasture, and spot treatments of higher concentration would be possible and perhaps more practical.

Soil Treatments.

Small trials have been carried out in Malaya on the lines of those elsewhere using 2, 4-D herbicides for treating bare soil to inhibit weed seed germination. Chemicals used were Methoxone, Sodium 2, 4-D and the ethyl and butyl ester of 2, 4-D. The treatments were carried out before, after, and at time of planting bean seeds: beans were chosen as they are particularly susceptible to the effects of 2, 4-D. All treatments gave excellent control of weeds; germination of grass seeds even seemed to be affected, since such weeds at first made slow appearance.

Soil treatment at time of sowing inhibited the germination of beans, and treatment after planting, at the time when the young shoots were appearing, also killed the beans. Treatment a week before planting also affected the bean germination but not so seriously as in the other two cases. Tomatoes, another very susceptible crop, were planted in the soil 3, 4 and 5 weeks after the treatments had been done and these survived, showing that the effects of treatment had by then passed off. This method of weed control may prove useful for keeping land clear in gardens or nurseries between plantings or for ensuring that land is weed seed free before sowing a permanent crop such as grass.

Treatment Recommendations.

It is extremely difficult to lay down hard and fast rules about the application of 2, 4-D compounds because as previously mentioned there are many controlling factors which differ from one place to another. However, some generalisations may be made. Where spraying of established weeds in the absence of a crop is being carried out at least 10 lbs. per acre pure chemical may be used, but where a crop is present it is unwise to go above 2½ lbs. per acre.

In dealing with water weeds or weeds in rice fields, 1¼ to 1½ lbs. per acre is sufficient to control the broad-leaved and succulent weeds without injury to the rice. Soil treatments require approximately the same dosage of 1¼ to 1½ lbs. per acre. Apart from these and certain other special considerations the carrying out of small trials is the most reliable method of approach to a new problem.

Summary.

1. 2, 4-D compounds and M.C.P.A. have been successful for control of broad-leaved weeds in rice fields and water courses in Malaya. Water-hyacinth is easily and economically destroyed.

2. Most sedges have been partially controlled but not readily killed, but grass weeds of padi-fields and water courses have not been affected.

3. Old established weeds have proved difficult to eradicate and up to four times the usual recommended dosages may be required.

4. *Mimosa pudica* has shown resistance to treatment with 2, 4-D, but control has been obtained in pasture using M.C.P.A.

5. *Cyperus rotundus* has been found to be very resistant, but trials are continuing.

6. Soil treatments, especially with water soluble compounds, have proved successful in keeping bare ground weed free for short periods.

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MECHANIZATION

Quarterly Progress Report, July to September, 1949.

Compiled by the Acting Chief Field Officer.

Recent Importations and Tests.

The following tractors and implements were received during the month:—

Cutter bars for B.M.B. Plow-mate.

Tool bars for Ransomes M.G.2 tractor with cultivators, hoes, ridging bodies, banking bodies and potato-lifting bodies.

Disc-harrow for Paraframe Toolbar for Standard Fordson tractor.

Wide front-axle and steel wheels for Farmall 'H' tractor.

Ransomes Shugadisc, 4-furrow disc-plough.

Federal Experiment Station, Serdang.

(i) *Ferguson Tractor and Implements.*

Costing trials with the three Ferguson ploughs were conducted; ploughing with the 2-furrow, 10 ins. mould-board plough working under fairly easy conditions to a depth of about 8 ins. over a period of 3½ hours gave running costs of $3.56 per acre; when ploughing with the 12 ins. 2-furrow plough under slightly more severe conditions running costs were $4.38 per acre; ploughing with the 16 ins. single-furrow mould-board plough to between 8 ins. and 9 ins. under difficult conditions in tall lalang cost $9.28 per acre; in this last case stoppages were frequent because of clogging with lalang and trash. These tests were made with a tractor that had not been "run in". The costs include charges for operators' wages and fuel only.

In the General Nursery the Ferguson tractor with a 3-body ridger was used to set up ridges for sweet potatoes. An area 5 x 1 chain was ridged in 25 minutes. The ridging bodies were also used to make propagation beds for fruit. After ridging, manure was spread by hand in the furrows and the ridges were split. Considering the restricted space in which this was done, an excellent job was made.

The steerage hoe was used with success for weeding between Dallas grass. The spring-tined cultivator has been tried on several occasions for bringing lalang roots to the surface in ploughed and harrowed land. It is quick and fairly efficient at this work, but good penetration is only obtained in well worked, friable land. The same implement was used to cultivate between rows of Gliricidia trees planted 8 x 8 ft. and, because of its good manoeuvrability, was easily able to work the whole of an irregular shaped area planted in this way.

The disc-harrow is rather light as it stands and no great penetration is obtained. It is however very easy to control and, in the reduction of heavy grass, *Mimosa invisa,* cover crops and low secondary jungle growth, good and fast work was done with the front gangs of discs only, each side being weighted with approximately 200 lbs.

The 5 ft. cutter-bar is a handy implement and was tried on several occasions. It makes a good job of cutting, even under fairly difficult conditions. It suffers from the drawback that, when being transported, the cutter-bar is suspended from the power-lift, and, if the power-lift arms fall as the machine is going along, it is necessary, before raising it again, either to disconnect the power take-off from the mower or to put the cutter-bar into the mowing position.

The following are approximate costs for the various operations performed (operator and fuel only) :—

	per acre $	
Grass cutting	1.95	(with attendant)
Cultivator	3.60	
Disc-harrow	1.30	
Discs with weights (one gang only)	3.30	
Straight-tine cultivator	2.20	

(ii) *Bristol 20.*

A new Bristol 20, on loan from the local agents for the machine, was also received. Unfortunately the only integral implement which was available was the 2-furrow Tru-Trac plough. This could plough 0.35 acre per hour, using 0.91 gallon petrol when ploughing to a depth of about 7 ins. in hard ground. Very little track-slip occurred, even in sticky conditions, and it is considered that the new Bristol has distinct advantages over the earlier model.

Chenderong Balai, Perak.

Owing to frequent rainy spells the padi fields did not dry sufficiently well for mechanical cultivation, and little serious work was done. A 'checker', an implement for the construction of bunds, made locally from an American pattern, was tested and would probably work satisfactorily in good conditions. The Cuthbertson ditcher, 'F' model, with the wheels replaced by " Athay " tracks was tested and worked very satisfactorily in areas in which there was little timber; however, even a small quantity of timber in the soil prevented its use. The ditching body was therefore removed and two teeth from a root-rake attached in its place in order to form a rooter. The conditions are not yet suitable for this to be tested.

Kelantan.

Weather conditions have been good and the programme for the mechanical cultivation of field experiments in progress has been followed

without any delays caused by weather, mechanical failures, or the incidence of the fasting months. Experiments have also been started at three sites on small-holders' land, equipment being used on these areas when it was not required on Padi Stations for investigational work. The 'Rotavator' attached to the Standard Fordson interested the local cultivators who thought that the principle was excellent; some of them might have been tempted to transplant immediately had nurseries been ready. It has, however, a very limited " lift " and the tractor frequently became bogged. In its present form the machine appears likely to be able to work only in favourable conditions, that is to say when there is a very hard " bottom " close to the surface.

The newly arrived Ferguson tractor was also tested, on standard steel wheels, with its three types of mounted ploughs; it performed very well and appeared to have plenty of power. It was later used on pneumatic tyres in an area the soil of which is described as " muddy to wet " and it ploughed most efficiently to both 4 ins. or 8 ins. as required. If pneumatic tyres have a wider range of applicability than was originally expected, they are likely to be the better choice, especially since inexperienced operators are less likely to bog a tractor with them than with steel wheels. The Ferguson power-lift cultivator and toothed harrow as well as the trailing disc-harrow were tested. The cultivator was slow and ineffective in reducing the furrow slice in these conditions; the toothed harrow was not well suited as it is mounted too low in front and clogged too readily. The disc-harrows worked well.

Province Wellesley.

An International Farmall 'H' with a 3-disc, semi-mounted disc-plough was used to prepare a rubber budwood nursery and performed well. The Ransomes M.G.2, 6 h.p. crawler tractor was tested in both wet and dry conditions in the padi fields. In many ways it gave by far the most promising performance of the lower powered tractors and it has an added advantage that the operator can ride on it instead of walking behind it. A new model, M.G.5, has recently been obtained. The standard type of this new model, in certain ways is not as suitable for work in wet conditions as the earlier model but it is considered that it can be fairly easily modified. The Allen Auto-Scythe with the more powerful 25A engine, on loan from the agents, was tested in off-season *menderong*; except that the more powerful engine allowed a smaller throttle opening to be employed without stalling and thereby improved ease of control there was little difference in the efficiency as regard height or evenness of cut over the older, less powerful model.

NOTES ON CURRENT INVESTIGATIONS, JULY TO SEPTEMBER, 1949.

Compiled by the Acting Chief Research Officer and the Acting Chief Field Officer.

Wet Padi.

Increased yields per acre are being sought by the use of improved strains, the use of fertilisers, and by improved methods of cultivation. Investigations carried out under the first head may be divided into: (a) the efficient utilisation of existing varieties and selected strains, and (b) the selection of better strains and varieties. Field trials with the existing strains are being conducted on a three-years plan and the final results will not be obtained until 1950; meanwhile the results of the 1948-49 varietal trials have been recorded and the analysis is nearly completed. Under (b) six varieties of padi are undergoing selection; they are Serendah Kuning, Nachin, Mayang Sa Batil, Radin Ebos, Siam and Seraup. In 1949 they are being replanted as selected lines and as mass selection plots. In the field of manurial trials, the widespread Malay practices of applying bat guano and dipping seedlings in a slurry of calcined bones are being investigated in nine experiments; work with phosphates, both as regards dressings and placement, is being conducted in three series. Pot experiments on the effect of trace elements in normal padi soils are in progress but no beneficial effect has yet been observed. A pot experiment with a Selangor peat gave poor results without fertilisers. There was a small response to potash and to phosphate, a much larger response to nitrogen, and a very large increase of crop due to complete N.P.K. Investigations into methods of cultivation are following two lines: the first consisting of mechanical investigations such as were described in the last issue of this Journal; the second, the testing of existing hand cultivations and the extension of the best types of such methods into new areas.

Dry Padi.

Investigational work on dry padi is confined to the States of Kelantan and Trengganu, where tests on methods of sowing and depths of cultivation by mechanical means are being conducted. Testing of varieties continues.

Cocoa.

The general policy outlined in an article in this Journal in April, 1949, (pages 59-69) is being continued. The eight experimental areas being laid down by the Department on its Agricultural Stations are progressing well and a further one is under consideration. The number of trial blocks on estates has been increased from 9 to 15, all of which have been planted,

and a further 10 will be planted in the near future. In addition, blocks interplanted with rubber, coconut, oil palm and Manila hemp have been planted on estates and one with rubber at the Experiment Station of the Rubber Research Institute of Malaya.

Investigations into the vegetative propagation of cocoa are proceeding and they have shown that the production of rooted cuttings and budded plants may be effected on a large scale. Before undertaking vegetative propagation of clonal cocoa from selected high yielding trees, however, their compatability has to be tested. At the Federal Experiment Station, Serdang, out of 10 selected trees, only three were self-compatible and therefore suitable for clonal propagation. Similar tests are being made on selected trees at the Cheras Agricultural Station, Selangor.

A large number of cases of apparently unhealthy plants has been investigated but in most cases no pathogenic organism is involved. Cocoa is however highly susceptible to *Ganoderma pseudoferreum*, and when planting, it is essential that a site free from this fungus be chosen. Investigations continue into the control of fungi and insects which attack cocoa.

Soils.

The selection of sites for the resettlement of Chinese squatters has necessitated investigational work both in the field and in the laboratory; in most States suitable sites have now been selected and resettlement is proceeding. Proposed new padi areas have been partially surveyed, and in view of the predominance of peat soils in these areas, and the expansion of pineapple cultivation on peat soils, much attention has to be given to the study of peat.

Abstract.

AGRICULTURAL EXTENSION AND ADVISORY WORK WITH SPECIAL REFERENCE TO THE COLONIES

*A report on a tour made in 1947 to study agricultural extension and advisory work in East and West Africa, England, Canada and the United States of America and Puerto Rico.**

The tour which this report covers was made during a training period preparatory to the secondment of the author to the newly created Lectureship in Agricultural Advisory and Extension Methods at the Imperial College of Tropical Agriculture in Trinidad. The main object of the lectureship is to give a wider view of their future duties to post-graduate students who undergo a year's pre-service training in Trinidad before taking up appointments as Agricultural Officers in the Colonial Agricultural Service.

It is not possible to give more than a brief abstract of this report, and this covers only the definition of agricultural extension and the conclusions. The full report merits close study by all interested in this important aspect of the work of Departments of Agriculture.

Definition

Agricultural extension is the term used to describe the complex of processes by which rural people are persuaded to adopt improved farming methods and improved ways of living. The success of an agricultural policy is measured in terms of its influence upon the lives and practices of rural people. The gap between the best scientific knowledge and current practice provides the field of scope for the extension worker, extension provides the bridge across that gap; it is a two-way bridge carrying information from the experiment station to the people, and bringing back knowledge based upon local experience, with further problems for investigation. The aim of extension work in general is not to provide personal service, but to teach people what to do and how to do it for themselves. This is fundamental and so often neglected by enthusiastic assistants who find it easier to do a job themselves than to teach others to do it. In practice, extension work must cover more than the giving of technical advice, it is concerned also with the organisation of rural people for rural betterment, and with the provision of related specialist services which individuals are unable to provide for themselves, such services for example as soil testing, livestock and crop improvement schemes, planning for soil conservation and so on.

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Conclusions.

Research and Extension.

The field of agriculture is broadly divided by Governments into Research, Formal Education, and Extension or Advisory Work. In developed countries the division of function is more clearly marked and comes at the national level; comprehensive extension services have been developed on a national scale, but only after nearly a century of research had provided knowledge to extend and half a century of formal agricultural education had provided suitably trained staff.

In the Colonies there is less specialisation in organisation and the division of function between research and extension comes at the district instead of the national level; a careful balance must be maintained between the two. The need for agricultural betterment is great, but Departments of Agriculture are of comparatively recent development. Farming traditions are ancient but primitive and research results are meagre. In the circumstances it is necessary for directed research of a short range character—what Dr. B. A. Keen calls " technological research "—to go forward just a step or two ahead of extension work. Senior staff trained and recruited in Britain or the Empire, bring with them cumulative knowledge based upon research in other parts of the world, but the application of that knowledge must be worked out locally on experiment stations, with long range research removed to extra-Colonial regional research stations. If extension work is to proceed smoothly it is essential that local problems be investigated in the order of their importance, and that the solutions found are within the capacity of the people to adopt. A warning must be sounded against the premature extension of results which may result in a loss of the people's confidence.

Organisation of Departments of Agriculture.

The basis of all extension services is a country-wide staff of local practitioners—agents, representatives, advisory officers or agronomes, in charge of local units of administration, counties or districts—serving under regional directors, in charge of states or provinces, supported by staffs of subject matter specialists.

The usual organisation of Colonial Departments on the territorial basis of Provinces, in charge of Assistant Directors, divided into tribal Districts, in charge of Agricultural Officers, corresponding with the administrative organisation of the colony, is excellent for extension purposes and corresponds with the set-up in most other countries. The provincial headquarters is ideally situated on a Provincial Experiment Station, where Specialists—botanist (plant breeder), chemist (soils, manures and feeding stuffs), agricultural engineer (soil conservation), agricultural education officer (staff training and liaison with education department)—are located. The Specialists serve the province in team with the District Agricultural

Officers. District officers are located upon District Experiment Stations with a subordinate staff of Assistants, Instructors and Demonstrators, distributed according to the tribal sub-divisions of the people.

It is generally better to concentrate limited staff in critical districts and to indicate the application of Government's general agricultural policy to the district administrative officers in the balance of the territory—supported by occasional inspection tours—than to dissipate energy over too large a field with the risk of achieving nothing everywhere.

When a district has passed the initial extension stage, it may be possible for junior staff to carry on with occasional supervision and to divert senior staff to open up other districts.

Importance of Junior Staff in Extension.

The junior staff is the true extension staff of the department and too much attention cannot be paid to their selection and training. Upon their enthusiasm, confidence, patience and personality the whole success of the Department depends. A rural background and a detailed knowledge of the system of farming it is desired to improve are of greater importance than academic qualifications; insistence upon the latter too often leads to recruitment of townsmen who can seldom make up later for lost early experience. Too often junior officers fail because they themselves have not confidence in the extension policy and they try to persuade farmers to take advice which they would not be prepared to follow on their own farms. Junior officers who have taken part in a survey develop a humble approach to the farmer and derive confidence and enthusiasm from a programme which they themselves recognise fits the local conditions; it is their job to close the gap. They take their tune from the District Agricultural Officer who should remain long enough in a district to be effective.

Importance of Surveys.

Extension must start on a level with the people and carry them forward, as a teacher does a class, a step at a time. The basis for an agricultural policy must be facts rather than opinions. For these reasons surveys must precede extension planning to indicate the problems for investigation, to provide a control for experiments, and to show how the answers to the problems can at a later stage be geared-in to local practice.

Confusion has arisen when agricultural betterment has been approached without preliminary surveys. Too often programmes have been based upon guesswork, the needs of external markets, or the personal interests of the investigator rather than the facts regarding the needs of the local people. In districts where extension work is not making progress it would be well to check to see if the programme really does fit local conditions and if the staff are approaching the work in the approved manner. In such cases it will generally be found that survey or local experience over a sufficient period is lacking or the extension programme is not based upon local trials.

Extension Work is Based Upon the Principles of Culture Variation and Culture Change.

Preliminary agricultural surveys must therefore be comprehensive and indicate local customs and social structure, and when results are being extended to other areas, no matter how similar superficially, cultural variations must be looked for which might influence the course of extension work. To neglect the sociological implications of an extension programme might lead at best to a waste of time through non-co-operation, or else to the creation of new problems more serious perhaps than the first. For example, the effects of the introduction of a cash crop to a subsistence economy or of a permanent cash crop or mixed farming systems on native land tenure must be anticipated.

Extension programmes must be flexible and continually subjected to review; they must march with the times.

Development of Extension in the Colonies.

When suitable answers have been found to immediate local problems, and only then, the extension phase can be entered upon and every appropriate extension method should be brought into play. Local leaders, who should be Chiefs and family heads or outstanding individuals approved by them, are contacted in the first instance and every effort should be made to encourage the formation of farming groups around them. The demonstration farm is generally an important extension method as the first step from the experiment station. The demonstration farm should be a farm of local unit size and pattern, incorporating the ideas it is desired to extend, the whole being capable of adoption by better local farmers. Demonstration plots on the farms of local co-operators may be employed effectively for demonstrating single factors. Demonstration would be accompanied by personal contacts with local leaders, general meetings, visual aids, short courses, loan schemes, seed supplies, agricultural shows and competitions, and so forth.

If survey indicates that basic changes such as the resettlement of population or collectivised farming, rather than modifications in existing systems, are likely to provide the best solutions for local problems, and their feasibility has been proved as far as possible by preliminary experiment, the first step in extension should be concentrated in a pilot area before expansion on a district scale.

Protective Legislation.

If survey indicates the need for protective legislation, facilities for the education of public opinion and for the enforcement of the legislation must be available. An educational campaign should be launched amongst the people so that the leaders, who will be responsible for interpreting the legislation, are brought to the point where they are so convinced of its desir-

ability that they ask the Government for its introduction. The introduction of such legislation also lends itself to treatment in pilot areas. The timing of extension campaigns is important as well as the methods employed.

Co-ordination of Policy.

Rural development should be a combined operation. The development of district and provincial welfare teams, consisting of senior officials in all departments under the chairmanship of the administrative officer on the lines of those set up in Kenya and Uganda, will ensure the unification of Government's policy in its different aspects.

Continuity of Staff and Policy.

Continuity of personnel, both senior and subordinate, is vital to successful extension. There is no worse failing of the Colonial Service than the opportunist method of staff posting. Extension aims at producing action in individuals, families and communities; success can be achieved only with an intimate knowledge of the people which cannot be acquired over a short period. It is very desirable that the officer responsible for the initial survey should at least see the district developed to the extension stage. Policy should be based upon the facts shown by survey and experiment. The team of district officers and specialists should be maintained within the Province as far as possible. By working in this way, continuity of policy and outlook can be assured on a regional basis. It would make for better understanding and less friction and jealousy within a Department if all provincial programmes could be considered together by provincial officers sitting in conference with the Director.

Fundamental to successful extension is the confidence of the people, which can be won by a policy based upon their requirements coupled with continuity of personnel. The secret of success in extension is to take first things first; centre the programme on the next step in local rural development—it may be the development of water supplies, the use of manure, or a plough, a disease resistant crop, a dry season fodder, a famine reserve or improved diet—having achieved success in meeting one recognised local need, subsequent progress is less difficult and local co-operation is assured. The extension worker knows he is achieving success when the people start to set the pace. In developing a policy it should be remembered that it is the small advance by the many which generally counts for more than a great advance by a few. It is generally possible to divide policy into two parts, one part calling for general action, such as the control of erosion, the control of grass burning, the making of manure, or rotational grazing on communal pastures; the other appealing for individual action such as the use of a plough, the digging of a well, the planting of a fruit tree or a firewood plot, or the making of a vegetable garden.

In Conclusion.

Problems of development and welfare in the Colonies are largely rural; there has been a tendency however for Colonial Governments to overlook the significance of well balanced Departments of Agriculture in this respect and to build up new departments for social welfare mainly urban in outlook and approach. Given adequate funds and staff and a broader interpretation of their functions, Agricultural departments have unquestionably a vital part to play in Colonial betterment and their development represents a sound investment. Administrations should be made aware of this. In conclusion, Departments of Agriculture must never forget that it is the people who matter not the soil, the crops, or the livestock except in their relation to the total prosperity and happiness of the people.

DERRIS MARKET PROSPECTS

The following information on derris market prospects has been supplied by the United Kingdom Board of Trade.

" It would appear that synthetic insecticides have replaced derris for a number of purposes, for instance the use of derris in sheep dips seems likely to disappear entirely in the course of time, while its replacement by D.D.T. and B.H.C. in the control of cabbage caterpillars and flea beetles is probably permanent. Changes of this kind have been more extensive in the U.S.A. than in this country, but with less caution, and as derris is a perfectly safe insecticide and its properties well known by long experience, it is not unlikely that a reversion of feeling as to the hazards to health attaching to the use of some of the synthetics might provide a fresh interest in derris. It would also appear that there is likely to remain a small, but steady market for derris:—

(i) Against certain pests e.g. the raspberry beetle, which is said to yield better to derris than to other products.

(ii) In situations where safety is the main consideration."

Departmental Notes.

Promotion.

The Right Honourable the Secretary of State for the Colonies has been pleased to approve the promotion of Mr. R. G. Heath, Senior Agricultural Officer, to be Chief Field Officer, Malayan Agricultural Service, with effect from 10th November, 1948.

Appointments.

Mr. R. G. Heath, Chief Field Officer, has been appointed to act as Deputy Director of Agriculture, Federation of Malaya, with effect from 20th September, 1949.

Mr. E. J. H. Berwick, Agricultural Officer, has been appointed to act as Senior Agricultural Officer (Research) with effect from 20th September, 1949.

Leave.

Mr. C. W. S. Hartley, Agricultural Officer, has been granted 240 days leave, in addition to voyages, with effect from 25th August, 1949.

Mr. E. F. Allen, Agricultural Officer, has been granted 240 days leave, in addition to voyages, with effect from 8th October, 1949.

Dr. A. E. S. McIntosh, Deputy Director of Agriculture, returned from leave on 19th September, 1949, and resumed his acting appointment of Director of Agriculture, Federation of Malaya, with effect from 20th September, 1949.

Mr. J. Fairweather, M.B.E., Senior Agricultural Officer, returned from leave on 4th October, 1949, and resumed duty as State Agricultural Officer, Perak.

Mr. Gunn Lay, Teik, O.B.E., Chemist, returned from leave on 12th October, 1949, and has been appointed to act as Senior Chemist, with effect from that date.

Mr. J. R. P. Soper, Senior Agricultural Officer, returned from leave on 18th September, 1949, and has been appointed to act as Chief Feld Officer, with effect from 20th September, 1949.

Mr. J. R. Curry, Senior Agricultural Officer, returned from leave on 18th September, 1949, and assumed duty as State Agricultural Officer, Selangor, with effect from 22nd September, 1949.

Mr. H. J. Simpson, Agricultural Officer, returned from leave on 10th October, 1949, and has been appointed to act as State Agricultural Officer, Pahang.

Mr. H. M. James, M.C., Agricultural Officer, returned from leave on 19th September, 1949, and assumed duty as Agricultural Officer (Research) at the Federal Experiment Station, Serdang, Selangor, with effect from 20th September, 1949.

Mr. H. Ritchings, Assistant Agricultural Officer, returned from leave on 19th September, 1949, and has been appointed Officer-in-charge, Waterfall Gardens, Penang, with effect from 21st September, 1949.

Transfers.

Mr. D. G. Jones, Agricultural Officer, has been transferred to Tanganyika with effect from 11th October, 1949.

Mr. H. D. Matheson, Agricultural Officer, was transferred from the Federal Experiment Station, Serdang to the post of Agricultural Officer, Perak South, with effect from 24th September, 1949.

"CATERPILLAR" TRACTORS

There has in the past been some doubt as to the correct horse power of "Caterpillar" tractors being used by the Department of Agriculture. To clarify the position the following information has been received from the Agents.

It should be noted that all "Caterpillar" tractors used by the Department are pre-1947 models.

Model	Pre 1947 Models		Post 1947 Models	
	Draw Bar h.p.	Belt or Brake h.p.	Draw Bar h.p.	Belt or Brake h.p.
D.2 ..	25.86	31.99	32	38
D.4 ..	35.68	41.47	43	48
D.6 ..	55	65	65	75
D.7 ..	69.41	82.04	80.44	92.84
D.8 ..	113	—	130	144

Statistical.

MARKET PRICES

July to September 1949.

Rubber.—The greatest alteration in the Singapore price of No. 1 R.S.S. f.o.b., in bales, during the third quarter of the year came in September with the announcement of the devaluation of the pound sterling. On the 17th September the price was 36⅞ cents per lb. and on Monday the 19th it increased to 43¼ cents.

In July the price increased from 32¾ cents on the 1st to 34¼ cents on the 21st but fell back to 33⅝ on the 29th, giving an average for the month of 33.32 cents per lb. A steady increase from 33½ to 36½ cents per lb. was made in August, the average price for the month being 34.64 cents. With the announcement of the devaluation of sterling the average price increased to 39.85 cents per lb. in September.

The average prices paid for small-holder's rubber at three centres during the third quarter of 1949 are given in Table 1.

Table 1.

Average Monthly Prices Paid by Local Dealers for Small-Holders' Rubber, July-September, 1949.

(Dollars per picul of 133⅓ lbs.)

Grades	Taiping Perak.			Seremban Negri Sembilan.			Batu Pahat, Johore.		
	July	Aug.	Sept.	July	Aug.	Sept.	July	Aug.	Sept.
Smoked Sheet ..	38.25	38.50	46.75	40.50	42.00	48.30	35.30	36.75	44.20
Unsmoked Sheet ..	29.00	31.00	42.50	33.00	34.50	41.00	32.50	34.00	40.00
Scrap ..	12.00	12.00	16.00	15.00	17.00	18.00	10.50	13.00	15.50

Transport from Batu Pahat to Singapore by lorry, excluding duty, $1 per picul.

Tea.—The average price in Colombo for Malayan teas, as quoted in the Colombo Brokers' Association weekly report dated 20th September, 1949, was Rs. 1.89 per lb. The average prices of Ceylon teas were as follows, in rupees per lb.: High Grown Teas Rs. 2.27, Medium Grown Teas Rs. 2.01, Low Grown Teas Rs. 2.09.

Ceylon teas are subject to an export duty but non-Ceylon teas sold at auctions ex-bond in Colombo for re-export are not subject to this duty.

The retail price of Malayan tea (Boh) has remained at $2 per lb.

Palm Oil.—The majority of Malayan estate production of this commodity continues to be sold to the United Kingdom Ministry of Food. There has been no change in the price payable to producers of £82 per ton f.o.b. Malayan ports. The 5 per cent. *ad valorem* Malayan export duty is for buyers account.

Derris.—The Singapore price of this commodity, as quoted by the Singapore Chamber of Commerce, remained steady at $80 per picul from the beginning of July until the last week in September when it increased to $85 per picul.

Tobacco.—The average prices paid per picul for cured leaf in Kelantan during the third quarter of 1949, were as follows:—1st quality $325, 2nd quality $237 and 3rd quality $153.

Rice.—The rice ration in the Federation of Malaya was increased to 3½ katis per person per week during the third quarter, 1949. The controlled price of rice has remained at $28 per picul.

Table II.

Singapore Prices of Various Agricultural Products.

(per picul)

Product	September, 1949			August, 1949	July, 1949	Average Price 1948
	Highest	Lowest	Average	Average	Average	
	$	$	$	$	$	$
Copra:						
Sundried No. 1 ..	29.00	28.00	28.33	28.55	28.00	38.77
Coconut Oil ..	53.00‡	51.00‡	52.00‡	50.55‡	48.00‡	68.74
Coffee:						
Padang Bali No. 1	*	*	*	*	*	115.35
Palembang No. 1	*	*	*	*	*	72.19
Sourabaya No. 1	*	*	*	*	*	82.32
Pepper:						
Muntok White ..	560.00	505.00	529.00	492.80	412.00	181.63
Sarawak ..	*	*	*	*	411.00	180.63
Gambier:						
Rounds No. 1 ..	*	*	*	190.00	185.00	127.22†
Cube ..	55.00	48.00	50.66	49.00	49.50	*
Sago Flour:						
Lingga ..	12.00	12.00	12.00	12.20	11.50	18.55
Tapioca Flour:						
Malayan No. 1 ..	19.00	17.00	17.67	17.00	17.61	30.48

* Not quoted. † Average January-November.
‡ F.O.B. price.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1948	1949	1948	1949
January ..	3,821.9	3,793.0	664.1	799.9
February ..	3,659.8	4,007.0	677.9	821.4
March ..	3,567.6	4,055.6	633.0	860.1
April ..	3,598.6	3,999.3	699.4	808.3
May ..	3,076.5	4,120.9	597.4	809.2
June ..	2,420.1	4,321.5	431.0	791.2
July ..	3,245.5	4,461.3	564.9	931.0
August ..	3,617.8	4,398.2	690.2	906.0
September ..	4,283.4	4,234.9	827.2	858.9
October ..	4,376.6		899.4	
November ..	4,827.2		913.6	
December ..	4,762.4		873.0	
Total ..	45,257.4	(37,391.9)	8,471.1	(7,586.0)

In September 44 estates (planted area 81,626 acres) were in production out of a total of 51 oil palm estates (planted area 84,132 acres).

MALAYAN AGRICULTURAL EXPORTS, APRIL-JUNE, 1949.

Product	Net Exports in Tons.			
	Year 1947	Year 1948	April-June 1948	April-June 1949
Arecanuts	12,507	6,043	1,725	2,226
Coconuts fresh†‡ ..	62,873†	44,887†	15,347†	7,759†
Coconut oil‡	41,112	45,245	9,435	15,746
Copra‡	45,439*	28,625*	10,197*	6,272*
Copra cake	5,260*	12,176*	2,052*	10,362*
Gambier, all kinds ..	1,156	286	118	119
Palm kernels	5,245	6,462	2,464	2,194
Palm Oil	43,325	46,821	11,700	10,987
Pineapples, canned ..	2,611	4,073	514	1,644
Rubber¶	645,229¶	696,978¶	176,609¶	151,264¶
Sago,—flour	5,958	16,946*	1,456*	1,053
„ —pearl	2,404	19,084	4,194	644
„ —raw	6,415*	6,667*	1,001*	435*
Tapioca,—flake	52	304	77	258
„ —flour	6,490	1,999*	686*	299
„ —pearl	7,205	14,263	4,798	4,120
Derris	243	80	13	16
‡Copra equivalent ..	22,625	45,795	5,442	19,470

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA RICE STATISTICS.

Summary of Acreages and Production—Season 1948-1949.

State/Settlement	TOTAL WET AND DRY PADI				
	Area Planted (acres)	Area Destroyed (acres)	Area Harvested (acres)	Yield of Padi (gantangs)	Rice Production (tons)
Perlis ..	43,490	8,380	35,110	7,287,000	11,470
Kedah ..	277,390	41,640	235,750	51,241,000	80,690
Kelantan ..	173,760	1,860	171,900	41,561,000	65,460
Trengganu ..	54,470	160	54,310	12,849,000	20,230
Penang & P. Wellesley	41,190	3,950	37,240	6,715,000	10,570
Perak ..	129,220	1,410	127,810	33,074,000	52,090
Selangor ..	42,340	680	41,660	12,495,000	19,670
Pahang ..	49,460	6,940	42,520	7,769,000	12,230
N. Sembilan ..	34,310	—	34,310	10,350,000	16,300
Malacca ..	31,870	2,620	29,250	6,879,000	10,840
Johore ..	23,110	580	22,530	3,773,000	5,950
Total ..	900,610	68,220	832,390	193,993,000	305,500
Off-Season Crop ..	7,460	880	6,580	1,070,000	1,680
Total 1948-49 ..	908,070	69,100	838,970	195,063,000	307,180
Total 1947-48 ..	885,480	40,610	844,870	217,846,000	343,065

Acreage to nearest 10 acres. Yield to nearest 1,000 gantangs. Rice production to nearest 10 tons.

Conversion Rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.).

FEDERATION OF MALAYA RICE STATISTICS.

Summary of Acreages and Production—Season 1948-1949.

Wet Padi.

State/Settlement	Area Planted (acres)	Area Destroyed (acres)	Area Harvested (acres)	Average Yield per acre		Yield of Padi (gantangs) (000's)	Rice Production (tons)	REMARKS
				Padi (gantangs)	Rice (lbs.)			
Perlis ..	43,430	8,380	35,050	207	732	7,278	11,460	8,380 acres destroyed by drought.
Kedah ..	273,200	41,500	231,700	219	774	50,831	80,050	41,500 acres destroyed by drought.
Kelantan ..	141,550	1,280	140,270	266	939	37,354	58,830	1,280 acres destroyed by sea water, late planting, drought.
Trengganu ..	44,110	160	43,950	261	920	11,471	18,060	160 acres destroyed by sea water and rats.
Penang & P. Wellesley	39,400	3,870	35,530	183	646	6,510	10,250	3,870 acres destroyed by drought.
Perak ..	119,370	780	118,590	271	956	32,150	50,630	550 acres destroyed by drought. 230 acres abandoned due to bandit activity.
Selangor ..	40,850	350	40,500	304	1,072	12,315	19,390	350 acres not harvested due to late planting and pest damage.
Pahang ..	46,740	6,940	39,800	186	656	7,400	11,650	6,940 acres destroyed by flood.
N. Sembilan ..	34,290	—	34,290	302	1,065	10,349	16,300	2,620 acres destroyed by drought, pests and flood.
Malacca ..	31,810	2,620	29,190	235	830	6,869	10,820	
Johore ..	20,710	510	20,200	178	628	3,592	5,660	510 acres destroyed by floods and pests.
Total ..	835,460	66,390	769,070	242	854	186,119	293,100	
Off-Season Crop ..	6,990	880	6,110	166	586	1,011	1,590	
Total 1948-49 ..	842,450	67,270	775,180	241	850	187,130	294,690	
Total 1947-48 ..	802,730	37,740	764,990	272	960	208,323	328,070	

Acreage to nearest 10 acres. Rice production to nearest 10 tons.

Conversion Rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.).

FEDERATION OF MALAYA RICE STATISTICS.

Summary of Acreages and Production—Season 1948-1949.

Dry Padi.

State/Settlement	Area Planted (acres)	Area Destroyed (acres)	Area Harvested (acres)	Average Yield per acre		Yield of Padi (gantangs) (000's)	Rice Production (tons)	REMARKS
				Padi (gantangs)	Rice (lbs.)			
Perlis ..	60	—	60	141	497	9	10	
Kedah ..	4,190	140	4,050	101	356	410	640	140 acres destroyed by drought and pests.
Kelantan ..	32,210	580	31,630	133	469	4,207	6,630	580 acres destroyed by pests and owing to late planting.
Trengganu ..	10,360	—	10,360	133	469	1,378	2,170	
Penang & P. Wellesley	1,790	80	1,710	120	423	205	320	80 acres destroyed by drought.
Perak ..	9,850	630	9,220	100	353	924	1,460	480 acres destroyed by drought and pests. 150 acres abandoned due to bandit activity.
Selangor ..	1,490	330	1,160	155	547	180	280	330 acres not harvested due to late planting and pest damage.
Pahang ..	2,720	—	2,720	136	480	369	580	
N. Sembilan ..	20	—	20	35	123	1	—	
Malacca ..	60	—	60	169	596	10	20	
Johore ..	2,400	70	2,330	78	275	181	290	70 acres destroyed by pests.
Total ..	65,150	1,830	63,320	124	437	7,874	12,400	
Off-Season Crop ..	470	—	470	126	445	59	90	
Total 1948-49 ..	65,620	1,830	63,790	124	437	7,933	12,490	
Total 1947-48 ..	82,760	2,880	79,880	119	420	9,523	15,000	

Acreage to nearest 10 acres. Rice production to nearest 10 tons.

Conversion Rate: 635 gantangs padi = 1 ton rice (i.e. milling recovery = 63 per cent.).

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Small-holdings (Estimated)		Total	
	1948	1949	1948	1949	1948	1949
January ..	34,668	36,397	27,321	24,052	61,989	60,449
February ..	28,529	27,593	22,121	17,450	50,650	45,043
March ..	31,888	33,616	26,549	20,309	58,437	53,925
April ..	32,724	28,142	33,684	14,113† 16,744	66,408	14,113† 44,886
May ..	33,294	33,570	16,313	18,499	49,607	52,069
June ..	33,246	32,921	27,348	18,683	60,594	51,604
July ..	35,193	35,751	22,972	2,705† 20,137	58,165	2,705† 55,888
August ..	33,727	36,658	22,875	20,504	56,602	57,162
September ..	33,292	33,828	30,910	24,900*	64,202	58,728*
October ..	34,020		16,347		50,367	
November ..	34,149		27,822		61,971	
December ..	38,177		19,809		57,986	
Total ..	402,907	(298,476)	294,071	(198,096)	696,978	(496,572)
Total 1947 ..	359,865		285,364		645,229	

Small-holding production is estimated from purchases reported by dealers; prior to 1949 it was estimated from the formula: Production + imports + opening stocks = exports + consumption + closing stocks.

† Quarterly adjustment.

* Includes quarterly adjustment (deduction of 822 tons).

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Small-holdings (estimated)		Total		Oil Mills		Oil Mills	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
January ..	—	2,476	—	7,406	—	9,882	3,302	4,727	2,512	3,245
February ..	—	2,605	—	5,544	—	8,149	3,224	4,429	2,432	3,027
March ..	—	2,644	—	4,981	—	7,625	3,910	4,638	2,913	3,211
April ..	—	2,755	—	6,203	—	8,958	4,054	4,832	3,223	3,325
May ..	—	3,039	—	5,884	—	8,923	3,124	4,995	2,446	3,437
June ..	—	3,500	—	6,723	—	10,223	3,729	5,607	2,955	3,756
July ..	2,971	3,838	2,619	6,915	5,590	10,753	3,625	5,710	2,901	3,870
August ..	3,227	3,867	8,731	8,676	11,958	12,543	4,556	5,671	3,484	3,858
September ..	3,326		7,077		10,403		5,266		3,730	
October ..	3,371		10,037		13,408		5,535		3,933	
November ..	2,992		8,377		11,369		5,096		3,669	
December ..	3,124		8,767		11,891		5,743		3,772	
Total ..	(19,011)	(24,724)	(45,608)	(52,332)	(64,619)	(77,056)	51,164	(40,609)	37,970	(27,729)

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of small-holding coconut oil production are not available.

4. Small-holding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + small-holding production = exports + local oil mill consumption + estate stocks (closing).

5. Statistics of copra production prior to July, 1948, are not available.

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1949.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day Amt.		Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	m.m.	ins.								
Ipoh, Perak ..	91.0	72.8	81.9	97	69	80	75			7.48	190.0	2.22	15	12	2			187.95	6.27	
Port Swettenham, Selangor	88.9	73.0	80.9	93	71	81	75	85.6	86.2	2.34	59.4	0.64	11	9				174.65	5.82	
K. Lumpur, Selangor ..	88.9	73.5	81.2	94	72	82	76			5.14	130.6	1.31	16	13	5	4				
Sitiawan, Perak ..	88.4	72.9	80.7	92	70	82	76	85.2		4.17	105.9	1.29	12	8	3	1	1	186.75	6.23	
Kuala Lipis, Pahang ..	90.0	71.9	80.9	94	69	79	74			3.85	97.8	1.29	22	12	9	16	2	159.95	5.33	
Kuantan, Pahang ..	87.8	72.2	80.0	93	69	78	75	84.4	84.9	5.15	130.8	1.32	18	13	2	25		144.25	4.81	
Temerloh, Pahang ..	73.3	–	–	–	71	–	77			4.65	118.1	1.24	15	11	10	9		153.15	5.11	
Bayan Lepas, Penang ..	87.2	74.8	81.0	90	72	82	77			10.10	256.5	1.87	20	17	8			197.25	6.57	
Malacca ..	85.6	74.1	79.8	87	70	79	76			9.59	243.6	2.64	18	15	3		3	176.75	5.89	
Mersing, Johore ..	87.3	72.8	80.1	91	69	76	75			6.64	168.7	1.25	17	15	5	1	1	170.80	5.69	
Alor Star, Kedah ..	88.0	74.3	81.1	92	72	82	77			6.90	175.3	1.64	16	22				189.85	6.33	
Kota Bharu, Kelantan ..	–	74.2	–	–	71	–	77	87.8		3.84	97.5	1.28	8	6	2	1		179.45	5.98	
K. Trengganu, Trengganu	–	73.8	–	–	71	–	77			1.52	38.6	0.79	10	5	4	1	1	147.60	4.92	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	74.6	63.0	68.8	78	61	68	65	72.8		5.01	127.3	1.42	14		3	16	1	164.55	5.49	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.8	55.6	64.2	76	51	67	61	68.3	70.0	6.01	152.7	1.25	18	16		2		125.85	4.19	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JULY, 1949.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall									Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days						Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more				
										ins.	m.m.	ins.									
Ipoh, Perak ..	90.9	72.0	81.5	95	70	83	75			10.04	255.0	2.19	15	13	3		1		195.85	6.32	
Port Swettenham, Selangor	88.6	72.6	80.6	92	71	84	74	83.9	85.2	10.53	267.5	3.53	18	15	3		1		186.30	6.01	
K. Lumpur, Selangor ..	88.9	72.8	80.9	93	71	85	75			5.89	151.9	1.58	18	12	2	4					
Sitiawan, Perak ..	87.6	72.1	79.9	90	70	80	74	84.2		7.52	191.0	1.97	19	14	4				182.15	5.87	
Kuala Lipis, Pahang ..	87.8	71.5	79.7	90	69	84	74	83.6	83.8	9.51	241.6	2.65	16	12	2	22			180.50	5.82	
Kuantan, Pahang ..	89.9	71.5	80.7	92	69	85	73			4.72	119.9	0.79	13	12	2	2			212.75	6.86	
Temerloh, Pahang ..	–	72.9	–	–	71	–	75			4.13	104.9	1.48	16	9	1	9			197.15	6.36	
Bayan Lepas, Penang .	86.2	74.0	80.1	89	71	79	77			17.09	434.1	5.16	19	16	7		3		178.20	5.75	
Malacca ..	84.7	73.5	79.1	87	72	81	75			5.43	137.9	2.01	15	10					212.30	6.85	
Mersing, Johore ..	86.9	72.0	79.5	90	70	83	74			3.64	92.5	1.00	12	11	1				197.70	6.38	
Alor Star, Kedah ..	86.6	73.6	80.1	91	71	80	76			11.43	290.3	2.18	19	17					173.25	5.59	
Kota Bharu, Kelantan ..	–	73.5	–	–	71	–	76	86.3		5.87	149.1	2.21	11	8	3				195.70	6.31	
K. Trengganu, Trengganu	–	72.5	–	–	70	–	76			3.64	92.5	1.01	15	11	3		1		216.40	6.98	
HILL STATIONS.																					
Fraser's Hill, Pahang 4268 ft. ..	73.9	61.9	67.9	77	60	68	64	71.8		10.42	264.7	2.90	19	14		22	1		159.80	5.15	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.5	55.8	64.1	75	51	67	60	68.1	69.8	9.73	247.1	1.87	24	20		2			125.40	4.05	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1949.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	m.m.	ins.								
Ipoh, Perak ..	90.9	71.9	81.4	94	69	83	76			8.69	220.7	1.70	20	17			1	197.10	6.36	
Port Swettenham, Selangor	89.2	72.0	80.6	92	69	86	74	84.7	85.0	4.48	113.8	1.36	22	11	1	1		208.20	6.72	
K. Lumpur, Selangor ..	89.9	72.4	81.1	92	70	85	74			5.06	128.5	2.70	16	12	5	3				
Sitiawan, Perak ..	88.1	72.3	80.2	91	70	80	75	84.0		7.30	185.4	3.41	14	11	4	1		216.05	6.97	
Kuala Lipis, Pahang ..	88.1	71.2	79.7	91	69	82	74	83.7	83.9	7.62	193.5	1.90	14	12	4	22		178.70	5.76	
Kuantan, Pahang ..	90.1	71.1	80.6	94	67	84	75			5.40	137.2	2.15	15	13	2	7		222.55	7.18	
Temerloh, Pahang ..	–	72.3	–	–	69	–	75			6.73	170.9	3.12	14	11	2	11		215.00	6.93	
Bayan Lepas, Penang ..	86.1	74.7	80.4	89	71	79	78			15.16	385.1	4.94	20	16	5		1	206.70	6.67	
Malacca ..	84.9	73.3	79.1	87	70	82	76			4.34	110.2	1.28	16	11			2	215.30	6.95	
Mersing, Johore ..	86.3	74.4	78.9	91	69	79	74			5.99	152.1	1.35	15	11	1		3	214.05	6.90	
Alor Star, Kedah ..	87.4	74.0	80.7	90	72	83	77			5.74	145.8	1.36	15	12	2			205.25	6.62	
Kota Bharu, Kelantan ..	–	73.5	–	–	71	–	75	86.2		4.74	120.4	1.75	14	11	2			228.20	7.36	
K. Trengganu, Trengganu	–	72.3	–	–	69	–	75			6.59	167.4	2.19	12	9	5		3	232.30	7.49	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	74.2	62.4	68.3	78	60	70	64	72.4		5.81	147.6	1.41	16	15	4	11		191.80	6.19	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.6	54.1	63.3	76	48	68	62	68.1	69.8	7.43	188.7	1.10	21	19		3		143.20	4.62	

Compiled from Returns supplied by the Malayan Meteorological Service.